CHAPTER 3

AFFECTED ENVIRONMENT

3.0 INTRODUCTION

The Affected Environment chapter of this environmental impact statement (EIS) for the proposed Cave Gulch-Bullfrog-Waltman Natural Gas Development project discusses environmental, social, and economic factors as they currently exist within the Cave Gulch-Bullfrog-Waltman project area. The material presented here has been guided by management issues identified by the Bureau of Land Management (BLM), Platte River Resource Area (PRRA); public scoping; and by interdisciplinary field analysis of the area.

This proposal could potentially affect critical elements of the human environment as listed in BLM's National Environmental Policy Act (NEPA) Handbook H-1790-1 (USDI-BLM 1988). This EIS discusses potential effects of the project on range resources, air quality, transportation, geology/minerals/paleontology, soils, water, vegetation and wetlands, wildlife, special status species, visual resources, noise, recreation, socioeconomics, cultural resources, and health and safety. The resources that are of concern in the project area include: air quality, cultural resources, floodplains, Native American religious concerns, wildlife, special status species, wastes (hazardous or solid), water quality, and wetlands/riparian zones.The following resource elements, while critical, are not present in the project area and therefore will not be addressed further: prime and unique farmlands, wild and scenic rivers, areas of critical environmental concern, and wilderness areas.

3.1 GEOLOGY/PALEONTOLOGY

3.1.1 Geology

3.1.1.1 Regional Geologic Overview

The Cave Gulch-Bullfrog-Waltman Area lies along the western edge of the Casper Arch and adjacent eastern edge of the Wind River Basin of Wyoming. Both the arch and basin are parts of the Wyoming Basin Physiographic Province, a province characterized by large intermontane structural basins that are bounded by mountain uplifts that have Precambrian rocks at their cores. Mountains in the province were uplifted during the Laramide Orogeny that began during the late Cretaceous times. Erosion stripped many of these mountains to their cores with the resulting sediments filling adjacent basins.

Similar to other Laramide Uplifts, the Casper Arch is bound on its west flank by a major east-dipping reverse fault system. Along this thrust system, the Casper Arch Thrust, the arch has been pushed westward over the edge of the adjacent Wind River Basin (Keefer 1970, Blackstone 1990). Unlike many of the other large mountain uplifts in Wyoming, the arch has not been elevated as high and thus has not been eroded as deeply. Upper Cretaceous marine strata are exposed over broad parts of the center of the arch. Progressively younger Cretaceous marine and Cretaceous and Tertiary terrestrial strata are successively exposed outward from the core of the arch to the northeast along its boundary with the Powder River Basin and to the southwest along its boundary with the Wind River Basin. The change from marine to terrestrial strata upward through the stratigraphic section exposed on the arch records the final withdrawal of the Cretaceous epicontinental seaway that covered wide areas of the central and western U. S.

The geology of the area has been mapped by the USGS and Wyoming Geologic Survey (Wyoming Geological Survey 1980, Love and Christiansen 1985, Lillegraven 1993, Love et al.1993) and this mapping documents that sedimentary deposits of Quaternary, early Tertiary, and Late Cretaceous age are exposed at the surface of the project area. Rocks southwest of, and in the foot wall of, the Casper Arch Thrust are relatively flat lying and dip between 3° and 10° to the southwest. In contrast, rocks northeast of, and along the leading edge of, the hanging wall of thrust dip steeply and are overturned and faulted in part. Surface sedimentary deposits are underlain at depth by Phanerozoic sedimentary rocks, that with the exception of lacking Silurian, Ordovician, and Devonian age rocks, range in from Cretaceous to Cambrian age. Silurian and Ordovician rocks, once present in the area were eroded during Early Devonian uplift of the Transcontinental Arch. Late Devonian rocks, if they were ever present in the area were eroded prior to Late Mississippian time during additional uplift in southeastern Wyoming (Snoke 1993). The Phanerozoic sediments are underlain by Precambrian metamorphic rocks that comprise part of the ancient North American cratonic shield. Information on the geologic units preserved beneath the project area is provided in Table 3-1. More detailed information on the geologic deposits exposed at the surface of the area is provided in Table 3-2. Geologic references pertaining to oil and gas geology are cited in the Wyoming Reservoir Management Group's 1996 report.

3.1.1.2 Mineral Resources

The primary economic resources within the Cave Gulch-Bullfrog-Waltman Area are natural gas and oil. Recognition of petroleum resources in Wyoming has a long history (Love 1978, DeBruin 1993). The first producing oil well in Wyoming was drilled west of the area at Dallas Dome in Fremont County in 1883. Studies of oil seeps from the Cloverly Formation of Cretaceous age along Wallace Creek (T33N R87W) in Natrona County were published soon after. M.P. Shannon and his associates from Pennsylvania drilled the first successful well in Natrona County in 1889 in the now abandoned Shannon Field, north of the Salt Creek Field. The first oil refinery was built in Casper in 1895 for the Pennsylvanian Oil Company, formed by Shannon and his associates, and had a capacity of about 100 barrels a day.

By 1980, more than 62 oil and gas fields had been discovered and developed in Natrona County (VerPloeg and Stephenson 1980), and several additional fields have been discovered since (DeBruin and Boyd 1991). The majority of these fields are located along the flanks of the Casper Arch and edges of the Wind River and Powder River basins. Oil and gas is produced from stratigraphic horizons in Tertiary, Cretaceous, Jurassic, Triassic, Permian, Pennsylvanian, and Mississippian formations. Information on oil and gas fields in the Cave Gulch-Bullfrog-Waltman Area is given in Table 3-3.

The main oil and gas producing horizons in the Cave Gulch-Bullfrog-Waltman and surrounding areas are the Tertiary, Wind River, and Fort Union formations, the Cretaceous, Lance/Meeteetse, Frontier, Muddy, and Cloverly (Lakota) formations. A few wells drilled in the project area prior to

Table 3-1. Subsurface Geologic Deposits - Cave Gulch-Bullfrog-Waltman Area (Love and Christiansen 1985, Love, Christiansen and Ver Ploeg 1993).

Geologic Deposit	Geologic Age	Environment/Lithology
Lance Formation	Late Cretaceous	Terrestrial/shoreline brown and gray sandstone shale thin coal and carbonaceous shale
Meeteetse Formation	Late Cretaceous	Terrestrial/shoreline tan to brown sandstone gray to black siltstone and shale carbonaceous shale and thin coals
Mesaverde Formation	Late Cretaceous	Marine/terrestrial variable sequence of gray and brown massive to thin-bedded sandstone and carbonaceous shale and coal beds; includes Teapot and Parkman Sandstone Members and unnamed middle member
Lewis Shale	Late Cretaceous	Marine gray shale containing gray brown sandstones
Cody Shale	Late Cretaceous	Marine gray soft shale and lenticular sandstone beds gray limy shale at base; includes Sussex and Shannon Sandstone Members
Frontier Formation	Late Cretaceous	Marine/deltaic gray sandstone and sandy shale
Mowry Shale	Late Cretaceous	Marine silver-gray hard siliceous shale with abundant fish scales and bentonites
Muddy Sandstone	Early Cretaceous	Marine/deltaic gray to brown sandstone conglomeratic
Thermopolis Shale	Early Cretaceous	Marine black soft fissile shale
Cloverly Formation	Early Cretaceous	Terrestrial variegated mudstone bentonitic conglomeratic sandstone
Morrison Formation	Upper Jurassic	Terrestrial vari-colored mudstones white sandstone bentonite
Sundance Formation	Jurassic	Marine green-gray glauconitic sandstone and shale underlain by red and gray non-glauconitic shale and sandstone
Gypsum Springs Formation	Jurassic	Restricted Marine/tidal flats interbedded gypsum dolomite limestone and shale in upper part massive gypsum and red shale in lower part

Table 3-1. Continued.

Geologic Deposit	Geologic Age	Environment/Lithology
Nugget Sandstone	Triassic	Eolian gray to red massive to cross-bedded sandstone
Chugwater Formation	Triassic	Terrestrial/mudflat red shale and siltstone sandstone
Dinwoody Formation/Goose Egg Formation	Triassic	Marine gray to olive dolomitic siltstone (Dinwoody); red sandstone and siltstone gypsum halite purple to white dolomite and limestone (Goose Egg)
Phosphoria Formation/Goose Egg Formation	Permian	Marine dark to light gray green to black glauconitic shale and sandstone phosphatic sandstone and dolomite (Phosphoria)
Tensleep Sandstone	Pennsylvanian	Marine white to gray sandstone with limestone and dolomite
Amsden Formation	Mississippian to Pennsylvanian	Marine red and green shale and dolomite persistent red to brown sandstone at base
Madison Limestone	Mississippian	Marine blue-gray massive limestone and dolomite
Gallatin Limestone	Cambrian	Marine gray glauconitic and oolitic limestone with flat pebble conglomerate and greenish-gray calcareous shale with minor thin-bedded limestone
Gros Ventre Formation	Cambrian	Marine green gray tan pink sandy shale and fine shaley sandstone crystalline limestone thin-bedded tan granular limestone and dolomite with flat-pebble conglomerate
Flathead Sandstone	Cambrian	Marine/shoreline red banded quartzose sandstone
unnamed metamorphic rocks	Precambrian	Igneous/metamorphic granitic and/or intrusive

Table 3-2. Summary of Geologic Deposits and Paleontologic Resources - Cave Gulch-Bullfrog-Waltman Area.

Geologic Deposit	Geologic Age	Type of Deposit/ Environment of Deposition	Fossil Resources	Paleontologic Potential	Area Present
alluvial sediments (including alluvium and colluvium)	Holocene	Unconsolidated silts sands of valleys and plains. Terrestrial-fluvial.	none known	low	widespread thin
eolian sediments	Holocene (less than 2000 ybp)	Unconsolidated active and dormant sands dunes sands and silts. Terrestrial-eolian	none known	low	widespread thin
fine sand and loess	Pleistocene	unconsolidated sand and loess developed as valley fill and subsequently eroded. Terrestrial-eolian	none known	mostly low , high where Eocene fossils concentrated	thin valley fill north of drainage divide between Cave Creek and Waltman Creek
Wind River Fm Lost Cabin Mbr	late early Eocene-early middle Eocene	Drab to varicolored sandstone mudstone Terrestrial fluvial flood-plain.	vertebrates invertebrates plants	high	eastern and northern part of area
Wind River Fm Arminto Mbr (=in part Lysite Mbr of Keefer 1965)	early Eocene	Drab to variegated sandstone and mudstone conglomerates typified by exposures at Hells Half Acre. Terrestrial-fluvial.	vertebrates invertebrates plants	high	as for Lost Cabin Member
Fort Union Fm Waltman Shale Mbr	Paleocene	Lacustrine	vertebrates invertebrates plants	low	exposed mainly east of area
Fort Union Fm Lower Mbr	Paleocene	Drab colored sandstones mudstones coals. Terrestrial pond swamp and fluvial.	vertebrates invertebrates plants	low	as for Waltman Shale Member
Lance/Meeteetse Fm	Latest Cretaceous	Terrestrial lagoonal and coastal swamp at base overlain by fluvial/flood plain	vertebrates invertebrates plants	mostly low	exposed as hogbacks in northern part of area
Mesaverde Fm (including Teapot Ss unnamed middle and Fales Mbr)	Late Cretaceous	Marine/Terrestrial. Teapot Sandstone and Fales Mbrs- marine unnamed middle member-terrestrial lagoonal swamp to fluvial/flood plain.	vertebrates invertebrates plants	mostly low	as for Lance/ Meeteetse Formation
Cody Shale	Late Cretaceous	Marine	vertebrates invertebrates	low	exposed only in extreme northeastern part of area

Table 3-3. Oil and Gas Fields in the Cave Gulch-Bullfrog-Waltman Area Exclusive of Cave Gulch.

Field Name (Discovery Date)	Location		Producing Horizon	Approximate Depth	Status
	T	R			
Arminto (1924)	37N	86W	Frontier	2000 ft	Shut-in
Boone Dome (1923)	35N	85W	Cody (Shannon) Frontier	1600 ft 6500 ft	Producing
Bull Frog (1978)	36-37N	86-87W	Cloverly subthrust Frontier Muddy Morrison Sundance	2400 ft 18800 ft 19900 ft 20300 ft 20500 ft	Producing
Clark Ranch (1955)	35N	84-85W	Frontier Cloverly Chugwater Tensleep	900 ft 2400 ft 3200 ft 4700 ft	Heavy Oil
Cooper Reservoir (1959)	35N	87W	Fort Union	3700 ft	Producing
Emerald (1975)	37N	84W	Tensleep	4000 ft	Producing
Frenchie Draw (1961)	37W	89W	Fort Union	8500 ft	Producing
Garrison Draw (1971)	37N	88W	Fort Union	8900 ft	Abandoned
Lox (1921)	37N	86W	Frontier	2000 ft	Abandoned
Madden (1968)	38-39N	89-91W	Wind River Fort Union Lance/Meeteetse Mesaverde Cody Madison	2900 ft 4700-11300 ft 11200-15100 ft 13200-18400 ft 16100-20600 ft 23500-23900 ft	Producing
Neal Reservoir (1978)	36N	88W	Lance	16000 ft	Shut-in
Notches Dome (1923)	37N	85W	Tensleep	2800 ft	Producing
Okie Draw (1953)	37N	85W	Tensleep	2800 ft	Heavy Oil
Powder River (1930)	36N	85W	Frontier Morrison	900 ft 2300 ft	Shut-in
Raderville (1955)	35N	89W	Cody (stray sand)	2000 ft	Producing
Rochelle Ranch (1987)	37N	86W	Frontier	2420 ft	Shut-in
Smith Canyon (1966)	35N	84W	Frontier	200 ft	Abandoned
Tepee Flats (1981)	37N	88W	Cloverly Frontier subthrust	9400 ft 15000 ft	Shut-in
Wallace Creek (1960)	34N	87W	Muddy	10300 ft	Producing
Waltman (1959)	36-37N	86-87W	Fort Union Lance	4400 ft 5700 ft	Producing

the Cave Gulch Field discovery in 1994 tested gas from the Mesaverde Formation but none of these wells were completed in that formation (WRMG 1996). In addition to the Mesaverde, natural gas reserves are present in the lower Fort Union, Lance, and Meeteetse formations. Specific drilling targets include point bar sandstones in the Fort Union, stacked meander belt sandstones in the Lance, and fluvial to marginal marine sandstones in the Meeteetse. Stratigraphic relationships of sandstone reservoirs within the target formations are complicated by vertical stacking of sandstone units and lateral discontinuities typical of fluvial deposits. The structure of the target reservoirs is complicated by the proximity of the southwestern edge of the Casper Arch and its bounding fault system, the Owl-Creek-Casper Arch Thrust System, as well as related subsidiary folds and faults. The southwest limit of the thrust system is defined by a northwest-trending topographic high developed in steeply-dipping to overturned and contorted strata of Tertiary and Late Cretaceous age that occur in the hanging wall of the fault. To further complicate structure, the northwest trend of the uplift is cut by several east-west trending lineaments that are probably related to normal faulting.

The WRMG estimated original gas reserves in place in the report area as about 1,557 billion cubic feet (BCF) of gas. Cumulative production through January, 1996 has been about 79 BCF with an estimated most likely remaining recoverable reserves of about 1,011 BCF.

Coal is present in surface outcrops of the Fort Union, Lance/Meeteetse, and Mesaverde formations along the western edge of the Wind River Basin, between Pine Mountain and Arminto. This area has been collectively referred to as the Arminto Coal Field (Glass and Roberts 1978). In places, these same strata are buried beneath a thin cover of alluvial and eolian sediments, and in other places by sediments of the Wind River Formation. Several coal beds exceeding 4 feet in thickness have been mapped in the vicinity of Powder River and Hells Half Acre (Jones 1991). At least eight abandoned underground mines occur in these outcrops between T31-36N R82-90W. These mines were all probably worked prior to 1910 during which time an estimated 150 million tons of coal was mined from them. An estimated 27 million tons of coal reserves remain. Analysis of coal samples from these mines, all reportedly from the Mesaverde Formation, are of subbituminous rank with heat values between 7530 and 8370 BTU/pound. They had an average moisture content of 26.9%, average volatile matter content of 28.8%, average fixed carbon of 37%, average ash content of 7.3%, and average sulfur of 0.6% (Glass and Roberts 1978). No major mining operations to recover remaining coal reserves are currently underway in the project area, and the economic viability of such projects is unknown.

Construction materials occur at widely spaced locations in the area. Recent alluvial and wind blown sands occur south of Arminto and south and east of Ralston Flats, north of the Burlington Railroad between Powder River and Ilco (Harris and Meyer 1986). Several gravel pits have been developed between Powder River and Waltman along US Highway 20/26 to exploit sand and gravel in unnamed deposits of Quaternary age and in the Wind River Formation (Hausel and Glass 1980, Harris and Meyer 1986).

Although not specifically noted in the project area, sandstones in the Mesaverde Formation elsewhere in Natrona County contain accumulations of black titaniferous sands (Houston and Murphy 1963, Keefer 1972, Hausel 1978). These black sands can be an excellent source of titanium, but apparently do not occur in sufficient concentration to have been economically exploited. Titaniferous sands can contain minerals of economic importance including sphene, rutile, anatase, titanomagnetite zirconium, monzanite niobium, and gold (Hausel 1993).

The Lance/Meeteetse, Mesaverde, and Cody Shale, elsewhere in Natrona County contain thick bentonite beds. Those in the Cody Shale, to the east of the project area, have been mined in the past (Dengo 1946). Bentonite is a commercial term for clays containing not less than 75% montmorillinite, and has been called "the clay of a thousand uses". Some major uses include as a binder in pelletizing taconites (siliceous iron ore), a lubricant sealant, a thickener in drilling fluid, as a sealant in waste water-isolation ponds, as a coagulant and cation exchanger in water and waste treatment, and as a mineral filler in many products. Most bentonite is now sold for use as a binder in taconite pelletizing. Before 1991, most bentonite was used in drilling fluid because of its swelling and colloidal ability (Hausel and Glass, 1980 Harris et al. 1985, Harris 1993).

The potential for uranium deposits in the Cave Gulch-Bullfrog-Waltman area is unknown. No published reports on uranium in the area were identified during literature search, and no existing mining claims have been identified within the project area. Of the geologic deposits that crop out in the project area, uranium deposits are known to occur in the Wind River, Fort Union, Lance, and Mesaverde formations elsewhere in Natrona County, Wyoming. Redox, roll-front, and tabular uranium deposits, important producers of uranium in Wyoming in the past, are known to occur in fluvial sandstones and conglomerates of the Wind River and Fort Union formations and deltaic sandstones in the Lance and Mesaverde (Teapot Sandstone Member) formations. Roll-front deposits occur in sandstones and conglomerates that are bound above and below by less permeable shales. Uranium ore along roll-fronts is commonly found where coarse-grained sandstones grade into finer grained or clay-bearing equivalents, which are commonly subparallel to pinchouts of sandstone-filled channels. Tabular redox uranium deposits occur in tabular bodies that are roughly parallel to bedding, unlike the roll-front which crosses bedding, and are often surrounded by non-mineralized, usually altered (oxidized), sandstone and conglomerate, or are bounded by impermeable rocks on one or more sides. Placer type uranium deposits, that have potential for future uranium production are known to occur in beach sandstones (black sands) in the Mesaverde Formation along with other heavy minerals (Harris and King 1993).

Uraniferous phosphatic lake beds, primarily of geologic rather than economic interest, occur in Eocene sedimentary rocks in the Lysite Mountains of eastern Hot Springs County and at one site in the Wind River Formation in Section 3, T35N, R85W (Harris 1997). Phosphorites appear to have formed in a restricted lacustrine environment.

Only minor uranium production has been reported in Natrona County outside of the Gas Hills mining district (Hausel 1980, Roberts 1989). The nearest production to the Cave Gulch-Bullfrog-Waltman area has been from the Hiland District (T37N, R88W). In the Hiland area, uranium mineralization occurs in a lenticular arkosic sandstone channel of the Wind River Formation and is restricted to a 10-foot wide, 1- to 5-foot thick, 2,000-foot long zone. Uranium concentrations in the zone reportedly ranged between 0.001 and 3.3 percent. In 1955, Highland Uranium Incorporated produced 9 tons of ore, containing 0.04 per cent U3O8, from the Bridger Trail prospect (T37N, R88W), developed in this zone. Uranex, Incorporated, and Great Basin Petroleum Company have since identified uranium reserves on the property of between 175,000 and 200,000 tons of ore.

Other uranium deposits occur in Natrona County in: (1) sandstones of the Lance Formation in the Pine Ridge Area (T39N, R77W); (2) black titaniferous sandstones in the Mesaverde Formation in the Coalbank Hills area (T35N, R88-89W) and Dry Lakes area (T35N, R79W); and (3) the Wind River Formation in a carbonaceous shale in the Poison Springs Creek area (T32N, R82-84W) and conglomeratic sandstones in the Clarkson Hill area (T31N, R82W).

3.1.1.3 Geologic Hazards

Potential geologic hazards include landslides, subsidence, and known or suspected active faults. In addition, shrinking or swelling soils can cause potential hazard to construction. Landslide potential is greatest in areas where steep slopes occur, particularly where the geologic dip of rock formations is steep and parallel to slope or where erosional undercutting may occur. No major landslides have been mapped in the report area (Case et al. 1991), and slope gradients are relatively mild over most of the area, with the exception of along the northeast facing escarpment (the Cave Creek escarpment) between the Waltman Creek and the Cave Creek drainage areas. Areas with unstable soils, particularly along this escarpment, may be susceptible to sliding and soil creep.

Two areas of minor landslides have been mapped north and east of the project area. These occur along Dean Springs Creek where slope gradients are steeper. Although not specifically mapped, small areas of potential mass earth movement are likely along certain areas of the South Fork of the Powder River, where stream incision may have steepened or undercut banks, and along the drainage divide described above.

Seismic activity is moderately low in the area. The nearest active faults with surface expression occur to the north and west along the south flank of the Owl Creek Mountains. The leading edge of the Casper Arch Thrust, the nearest major fault with near surface expression, occurs buried beneath Tertiary sediments a few miles west of Hell's Half Acre. No faults with Quaternary movement have been mapped by the Wyoming Geological Survey within the project area. Eleven epicenters of earthquakes have been mapped in Natrona County by Case et al. (1994). These earthquakes were reported from 1873 to 1975 and ranged in intensity from III to VII on the Modified Mercalli Intensity Scale of 1931, 3.2 to 3.5 on the Richter Scale, and 3.8 to 4.8 Body Wave Magnitude. The nearest epicenter to the project area occurred on December 10, 1873, in T35N R85W, and measured III on the Modified Mercalli Intensity Scale of 1931.

3.1.2 Paleontology

According to Wyoming BLM guidelines (Washington Office Instructional Memorandas WO-95-51 and WO-96-67) paleontologic resources include the remains or traces of any prehistoric organism which has been preserved by natural processes in the Earth's crust. Energy minerals such as coal, oil, shale, lignite, bitumen, asphaltum, and tar sands, as well as some industrial minerals such as phosphate, limestone, diatomaceous earth, and coquina ,while of biologic origin are not considered fossils in themselves. However fossils of scientific interest may occur within, or in association with, such materials. Fossils of scientific interest include those fossils of particular interest to professional paleontologists and educators. Vertebrate fossils are always considered to be of scientific interest; other kinds of fossils may be placed in this category by the State Director and District or Area Managers in consultation with BLM staff paleontologists or other experts.

3.1.2.1 Regional Paleontologic Overview

Paleontologic resources within sedimentary deposits in the project area record the history of animal and plant life in Wyoming during the Mesozoic and Cenozoic eras, specifically during the late Cretaceous, early Tertiary, and late Quaternary periods.

A technical review of existing data conducted for the Cave Gulch-Bullfrog-Waltman area established that the Wind River Fort Union Lance/Meeteetse and Mesaverde Formations had potential to yield scientifically important fossils of plants and animals ranging from late Cretaceous to early Tertiary age. The unconsolidated Holocene deposits present in the area were considered too young to contain fossils with the exception of where they contain fossils concentrated from the Wind River Formation.

Fossils known from the Wind River and Fort Union Formations in Wyoming include a wide variety of mammals, reptiles, amphibians, and plants. Vertebrate fossils document the diversification of mammals following the extinction of the dinosaurs in the Late Cretaceous and the origin and diversification of modern mammal groups in the Eocene. The formations also produce a wide variety of invertebrate and plant fossils. The Lance/Meeteetse Formation is the most prolific producer of late Cretaceous fossil vertebrates in Wyoming, and records an abundance and diversity of animals including sharks, rays, bony fish, amphibians, champsosaurs, turtles, lizards, snakes, crocodiles, saurischian and ornithischian dinosaurs, pterosaurs, birds, and marsupial and placental mammals and plants. Fossils known from the Mesaverde Formation include the remains of a wide variety of early mammals, marine fish (including sharks rays and bony fish), amphibians, reptiles, (including champsosaurs, turtles, lizards, snakes, crocodiles, pterosaurs, ornithischian and saurischian dinosaurs), and birds. The Cody Shale is known to yield the fossils of marine fish, including sharks and bony fish and unidentifiable marine reptiles at various localities in Wyoming. The Mesaverde and Cody also produce a wide variety of marine invertebrate fossils and their traces.

A field survey of the project area revealed fossil vertebrate remains at numerous localities in the Wind River and Lance formations (Figure 3-1). Fossil material from the Wind River Formation was derived from bone-bearing fluvial conglomerates and sandstones developed in the basal part of the formation (=Arminto Member) and from anthills, developed proximal to these conglomerates. One of these conglomerates is widespread over the central part of the project area, where it rests with marked angular unconformity above Paleocene and Cretaceous deposits, which are steeply dipping to overturned. The other conglomerates occur as channel lag deposits, developed at several higher levels throughout the Arminto member. Anthills producing fossils were constructed in both the Wind River sediments and the deposits of fine-grained sand and loess of probable Pleistocene age, that immediately overlies the Wind River Formation. Fossil materials may have been concentrated from the Wind River into the younger sediments while they were being deposited. Additional fossil vertebrate material was discovered in a sandstone "blow-out", or wind deflated area, developed in at the top of a channel sandstone in the overlying Lost Cabin Member of the formation that forms the top of the Cave Creek Escarpment. Where it forms the top of the

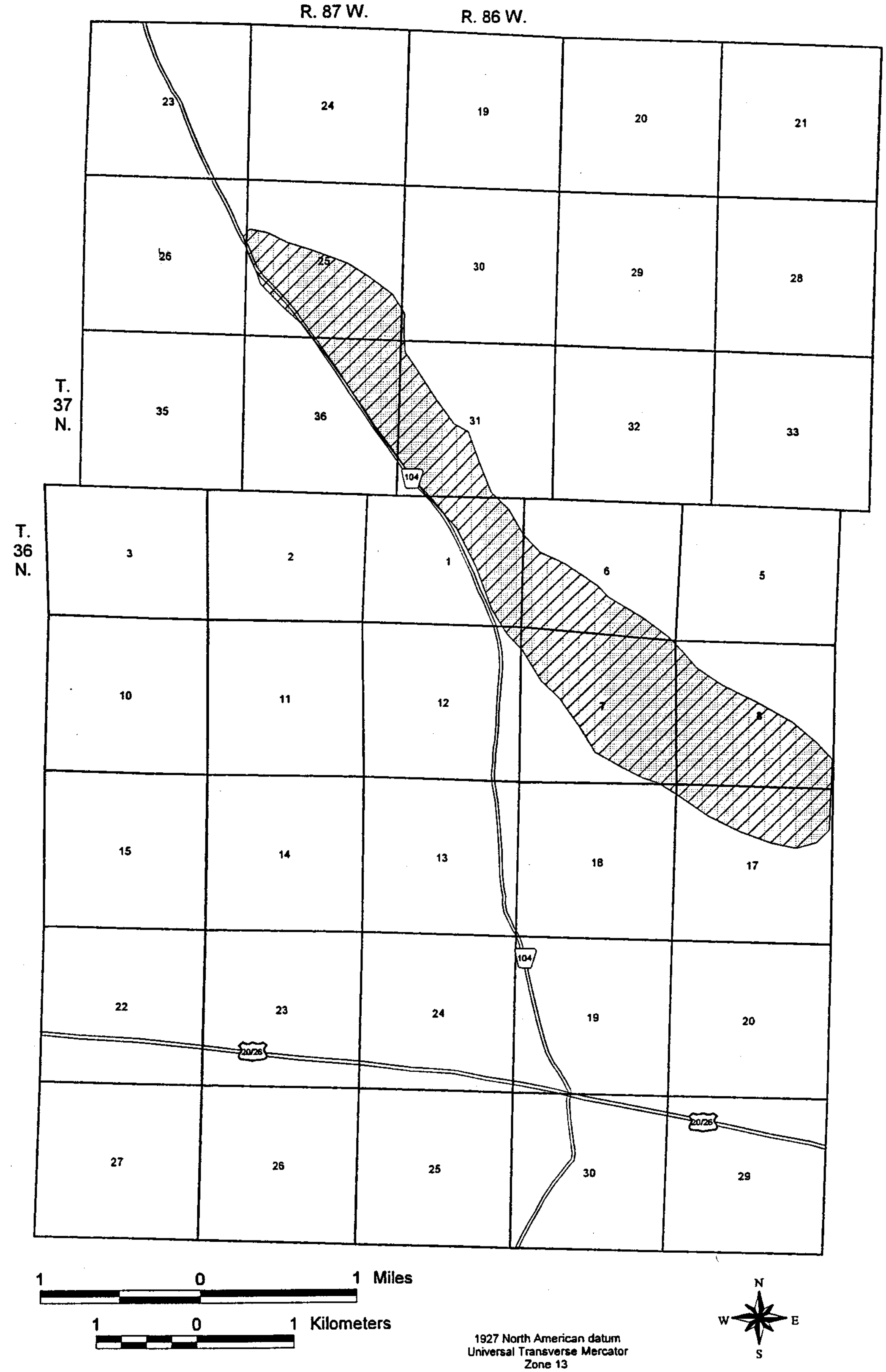


Figure 3-1. Area of High Paleontologic Sensitivity within the Cave Gulch-Bullfrog-Waltman Project Area.

escarpment, the member is not well-exposed and paleontologic potential was hard to determine by field survey. Monitoring of excavation, associated with the Express Pipeline which traverses the top of the escarpment, during the summer and fall of 1996 did not reveal any additional fossils.

Unidentifiable fossil vertebrate fragments and plant remains (including imprints and wood) were observed at a few locations in the Lance/Meeteetse Formation and although none of this material was deemed significant enough to collect, or warrant locality designation, these localities are included here for completeness. No fossil remains were identified in the Mesaverde Sandstone or Cody Shale. The former was well exposed, but the latter had very poor exposure in the study area, and anthills and animal burrow/diggings examined along the outcrop trend proved to be barren of fossil materials.

Information on geologic units that crop out in the project area is described in detail in Appendix E and is summarized in Table 3-2. Table 3-2 also includes information on the unnamed deposit of probable Pleistocene age discovered during the field survey and lists paleontologic potential rating for all the deposits in the area.

3.1.2.2 Paleontologic Potential Criteria

Criteria used to describe the paleontologic potential of geologic deposits in this investigation are as follows:

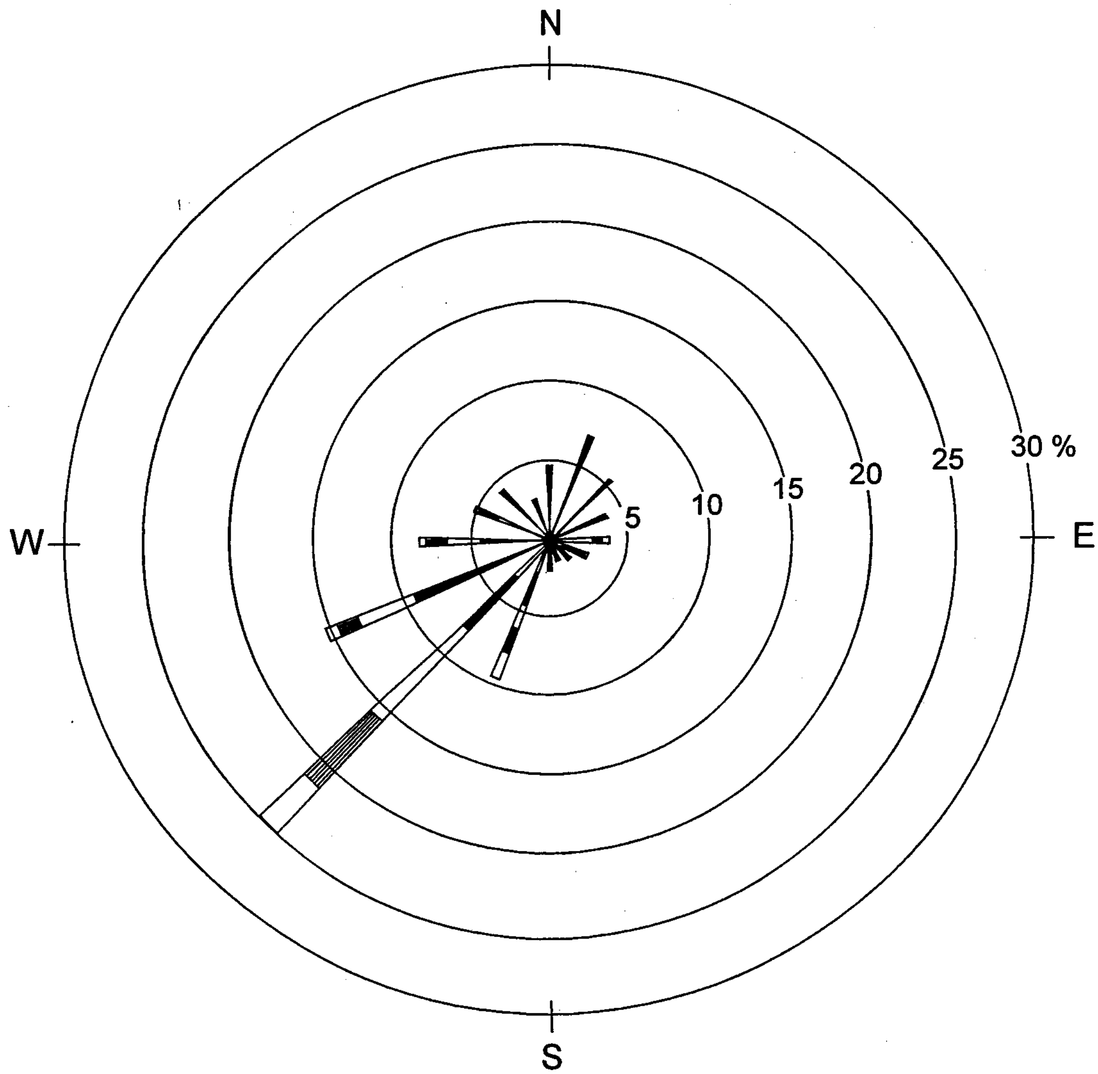
High Potential. Sedimentary units which are demonstrated by literature or museum records and field surveys to have produced scientifically significant fossils. These units are judged to be likely to produce significant fossils in the course of surface disturbance. Areas of high potential may be designated for an entire unit throughout its extent or only in areas or particular lithologies.

Low Potential. Sedimentary units that have been studied may be found through literature museum records and field surveys to have produced few significant fossils. These units are judged to be unlikely to produce significant fossils in the course of surface disturbance. Also included are units that may be considered to have a high potential elsewhere but that have been demonstrated by field survey to be unlikely to produce significant fossils in an area under study.

3.2 AIR QUALITY

3.2.1 Climate, Precipitation, and Winds

The project area is semi-arid, as the air masses arriving over the area come from the Pacific, and mountains to the west act as effective moisture barriers. The majority of the precipitation occurs as a result of late spring and summer thunderstorms, which coincide with the growing season. The remainder of the precipitation comes in the form of snowfalls, primarily from November through April, with heaviest snowfall in the spring. Annual average precipitation is 11.88 inches, with average maximum monthly precipitation of 2.10 inches in May (NOAA 1992).



WINDROSE
Casper, Wyoming
Period: 1987-91

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE: WIND IS BLOWING FROM THE NORTH 3.3 PERCENT OF THE TIME.

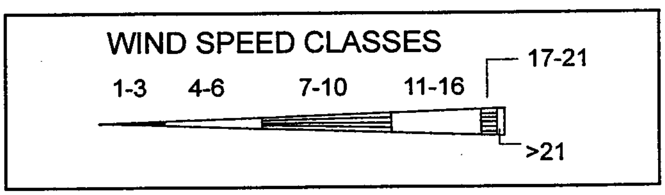


Figure 3-2. Wind Direction Rose for the Cave Gulch-Bullfrog-Waltman Area.

Monthly mean temperatures range from a January low of 22.7 °F to a monthly mean high of 70.8°F in July. However, as is characteristic of continental dry climates, temperature extremes are pronounced -- a record low temperature of -41 °F in December and a record high temperature of 104 °F in July have been measured in Casper (NOAA 1992).

Average winds are highly directional. As can be seen from the wind rose in Figure 3-2, winds from the southwest and west-southwest account for over 40% of the total hourly wind directions (SCRAM 1994). In fact, all monthly average prevailing wind directions recorded by NOAA (1992) at Casper occur either in the southwest or west-southwest directions, indicating strong directionality. Wind speeds are uniformly high in Casper, ranging from a monthly mean low wind speed of 10.2 mph in July, to a maximum monthly mean wind speed of 16.5 mph in January (NOAA 1992). The uniformly high wind speeds enhance dispersion, prompting lower pollutant concentrations than would occur in the absence of steady, high wind speeds.

3.2.2 Air Quality

Current and complete monitoring data for ambient air quality are not available for the Cumulative Impact Study Area. However, based on data collected in similar locations, air quality levels are assumed to be in attainment for all State of Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS). These data and standards are summarized in Table 3-4.

The estimation of background concentrations is necessary in order to compare potential air quality impacts from the Proposed Action and Alternatives with applicable air quality standards. Thus, for comparison against an applicable standard, total impacts are the sum of the modeled impacts plus the background concentration. It is important that the model predictions, background concentration and applicable air quality standard are for the same averaging time period.

Background pollutant concentration data were provided by the WDEQ/AQD. Background concentrations of carbon monoxide (CO) are taken from representative data collected by WDEQ/AQD and commercial operators, and summarized in the Riley Ridge EIS (BLM 1983). Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) gaseous data were gathered at the Lost Cabin Gas Plant site in Fremont County (1986-87). Ozone data were taken from Pinedale, Wyoming (1993-1994 -- 90th percentile maximum 1-hour value). The particulate data (TSP and PM10) were collected in an urban area at the Casper City and County Building (1995).

3.3 SOILS

3.3.1 Introduction

Soils within the project area have been primarily derived from two sources: (1) Cretaceous sandstone and shales of the Lance Formation, Fox Hills Sandstone, and Lewis Shale (Klm) and (2) Quaternary windblown dune sand and loess (Qs) (Love and Christiansen 1985). Depending on the topographic position of a given location relative to the distribution of these parent materials, the soil texture ranges from loamy sand to clay.

Table 3-4. Background Air Quality Concentrations (in micrograms per cubic meter) and Applicable Standards.

Pollutant	Averaging Time [a]	Concentration($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	1-Hour 8-Hour	3,500 1,500	40,000 10,000	40,000 10,000
NO_2	Annual	2	100	100
Ozone	1-Hour	110	160	235
SO_2	3-Hour 24-Hour Annual	93 32 4	1,300 260 60	1300 365 80
TSP	24-Hour	70	150	n/a
PM10	24-Hour Annual	42 19	150 50	150 50

Note: [a] Short-term period concentrations reflect the maximum measured values during the entire period of record (i.e. 1993 through 1994, annual 1995, etc.)

Soils of the project area are classified in the Torriorthents, shallow association (USDI-BLM 1984a, U. of Wyoming 1977). The soils of this association formed in residuum and alluvium from interbedded sandstones, siltstones, and shales. Slope gradients range from 5 to 40 percent except in areas of bedrock exposure where gradients are greater, and surface textures are fine to medium (i.e., lack gravels and cobbles). The depth to bedrock ranges from 10 inches to over 60 inches where in some areas the bedrock is exposed. The depth to the water table is generally greater than 60 inches except along ephemeral and intermittent stream channels where the water may be near or at the soil surface for short times during the year. Soil permeabilities are mostly moderate with some soils having slow permeability. No prime farmlands or farmlands of state and local importance occur in the project area. Additional detail on soil resources is presented in the Soils, Water, and Vegetation Resources Technical Report (ECOTONE 1997).

The BLM has mapped topographic slope gradients in the project area. Approximately 96 percent of the project area has a slope gradient of 15 percent or less. Approximately 70 percent of the project area is in the 6 to 10 percent slope class. Less than one percent of the project area has a slope greater than 25 percent. Thus, most of the project area has relatively gentle slope gradients (i.e. less than 25 percent) where sensitivity to land and resource development is relatively low compared to areas with slopes greater than 25 percent.

3.3.2 Soil Map Unit Descriptions

The Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service (SCS)), in cooperation with the BLM, has prepared a preliminary Order III soil survey of Natrona County (USDA-SCS 1985). Maps presented in Order III soil surveys are prepared at a scale of 1:24,000 (or 1 inch per 2,000 feet). Therefore, the scale of resolution is much greater than the resolution for the soil association. These maps show the occurrence and distribution of soil mapping units that generally are comprised of one or more homogeneous soil series in a complex or association. Mapping units comprised of more than one series may have major components of highly varying soil characteristics. In addition, each mapping unit is also comprised of inclusions of minor differing soils. Therefore, the variability of soil characteristics within a soil mapping unit may be relatively great.

Twenty-four soil map units (MUs) have been delineated and mapped immediately adjacent to and within the project area as shown in Figure 3-3. These soil map units are variously comprised of sixty-seven discrete soil series (including 18 series that comprise minor inclusions in the map units). The physical characteristics of the soil mapping units and component series are summarized in Table 3-5. The character of the soil map units can be summarized by the following parameters.

As indicated, each soil map unit consists of one or more homogeneous soil series. The fact that a soil map unit is comprised of more than one soil type or series gives each map unit a high degree of internal variability. In other words, a map unit does not represent a homogeneous soil, rather it represents different soil types, each with its own specific characteristics; and therefore, has a large degree of variation of character. Thus a soil map unit does not represent a homogeneous soil area. This fact has implications on how the character of a soi map unit is interpreted. For instance, one map unit may contain three soil series, one of which is deep, non-sensitive, with good reclamation potential; a second that is shallow, sensitive, with poor reclamation potential; and a third series that is moderately deep, sensitive, with fair reclamation potential.

As discussed in a subsequent section, nineteen soil samples were collected in the project area and analyzed for various physical and chemical characteristics. Soil characteristics identified by the nineteen soil samples generally correlate with the descriptions of the soils prepared by the NRCS (USDA-SCS 1985).

Slope Phase and Topography. Slope phase correlates with the slope gradient of the topography of the project area. Topography in the project area (Figure 3-4) ranges from flat internally drained areas, to gently sloping hills and hillslopes, to steeply sloping hills, to the badland areas with fins comprised of exposed shale and sandstone bedrock. Most map units have a slope range of 0 to 30 percent, while few units have slope gradients higher than 40 percent.

Parent Material. Parent material includes the source bedrock as well as the mode of deposition of eroded bedrock particles. Principal bedrock types exposed in the project area includes shale, siltstone, and sandstone. Shale is the most common bedrock type. A large portion of the shale has a relatively high sodium content which causes certain adverse soil characteristics to develop. Many of the soil series developed from eroded bedrock deposits that include alluvium, slopewash, colluvium, and eolian or wind deposited sediments (i.e., dunal sands). The type of particles that comprise the sedimentary bedrock (i.e., clay, silt, and sand) determine to a large degree the texture of the soil that develops from that deposit.

Depth of Soil. The depth of soils in the project area is highly variable depending on numerous factors. Generally, soils on low slope gradients, concave topographic structures, and/or eolian deposits are deep to very deep (40 inches or greater). Soils on steep slopes or on convex

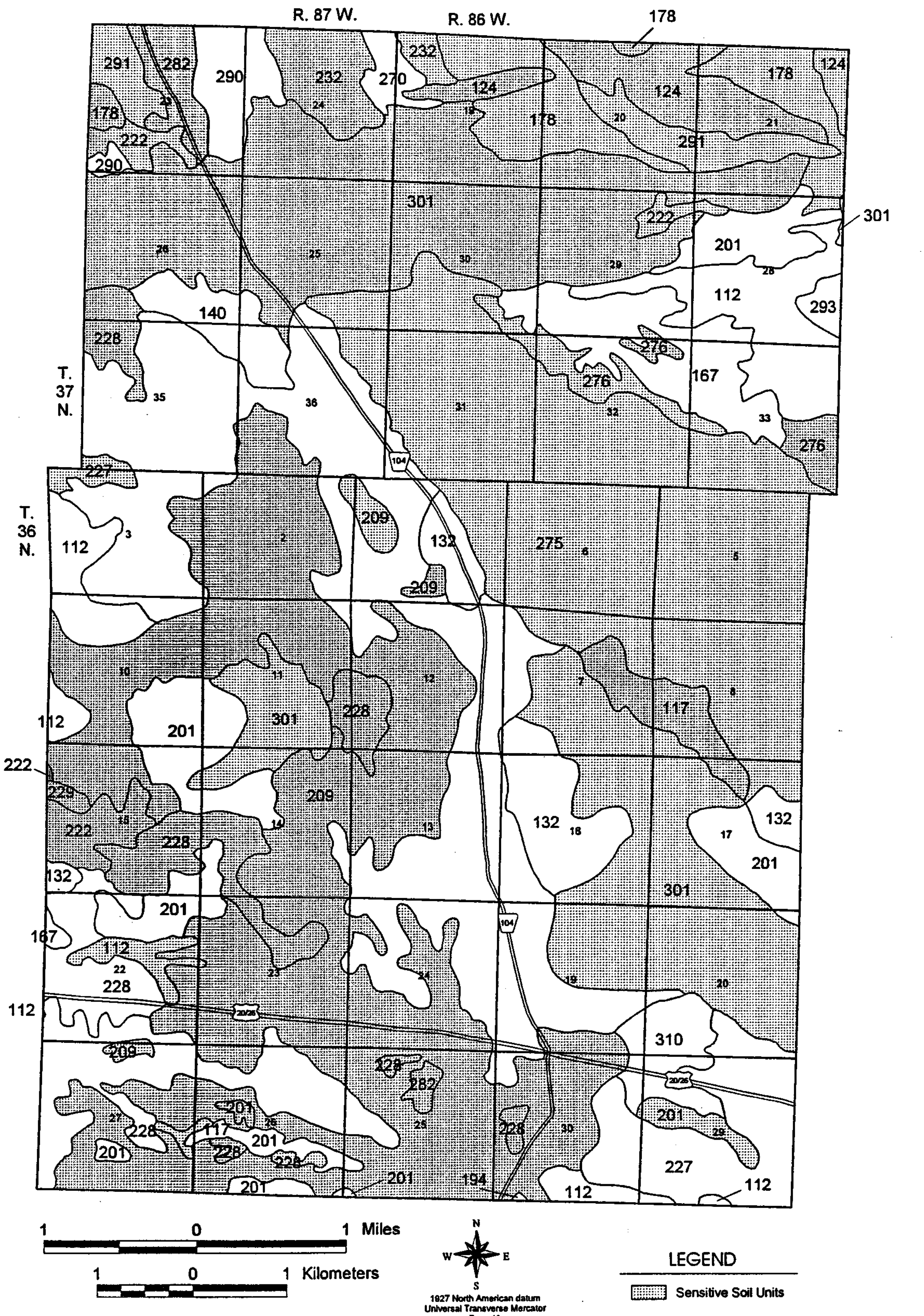


Figure 3-3. Soil Mapping Units and Sensitive Soil Categories within the Cave Gulch-Bullfrog-Waltman Project Area.

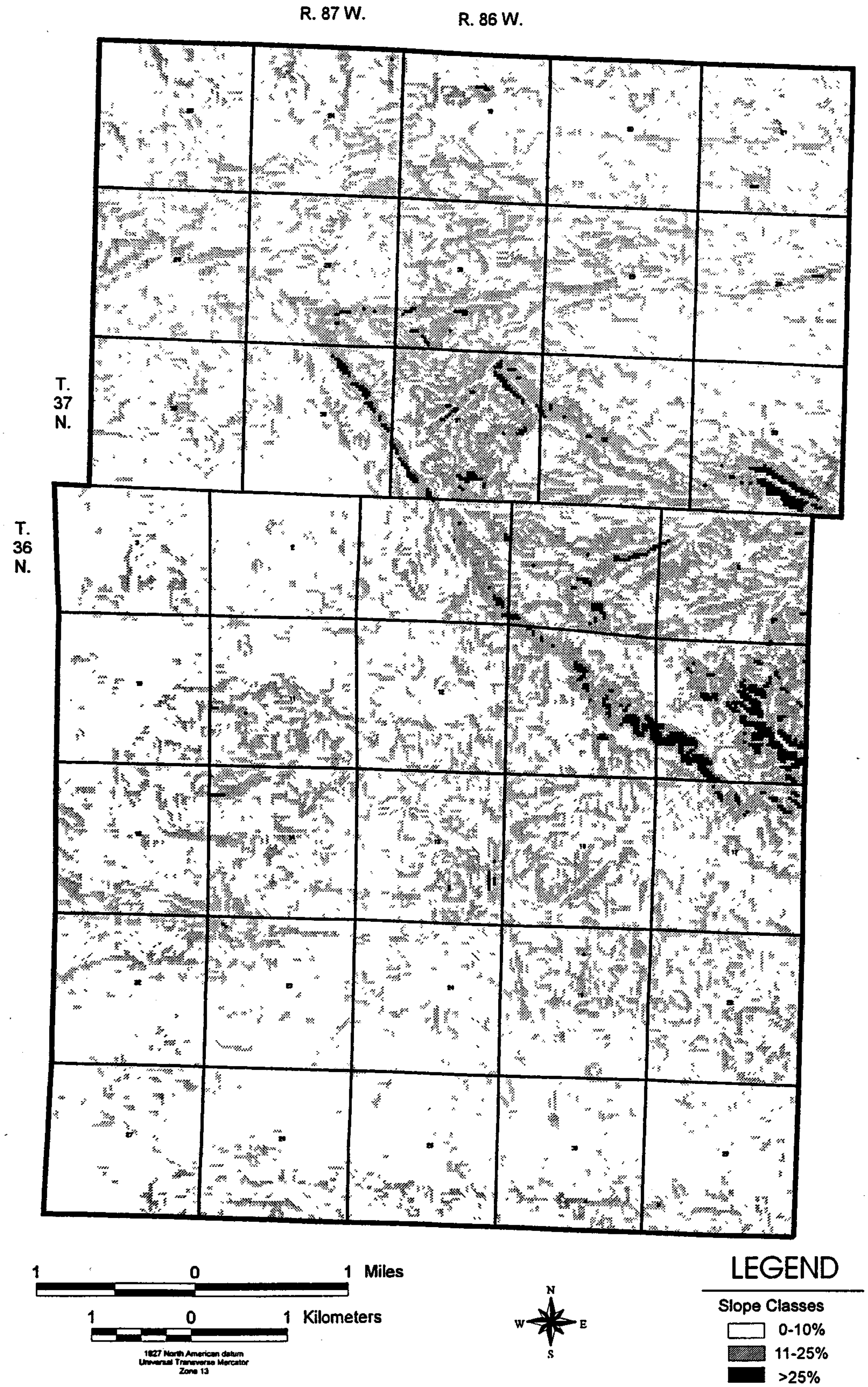


Figure 3-4. Slope Map of the Cave Gulch-Bullfrog-Waltman Project Area.

Table 3-5. Summary of Physical Characteristics of Soil Map Units in the Analysis Area.

Soil Map Unit #	Map Unit Name	Slope Phase	Topography	Series	Parent Material	Depth	Predominant Texture	Drainage	Permeability	Effective Rooting Depth
112	Arvada-Absted-Slickspots (20% inclusions: Keyner sandy clay loam on low hummocks, Silhouette clay loam, Cadoma clay loam, and Orella clay loam)	0-6 percent	alluvial fans, low terraces, 5,000-6,200 ft.	Arvada clay loam (25%)	sodic alluvium	deep	sandy clay loam	well	slow	>60 in
				Absted clay loam (30%)	alluvium from sodic shale	very deep	clay loam	well	slow	>60 in
				Slickspots (15%)	sodic shale	shallow	clay	poor	very slow	<60 in
117	Badlands (10% inclusions: small pockets of shallow to deep variable soils)	variable	steep hillslopes	Badlands	interbedded soft shale, siltstone, fine-grained sandstone	shallow	variable; bedrock to sandy loam to clay	poor to well	very slow to moderately rapid	0 to >60 in
124	Blackdraw clay loam (10% inclusions: Lolite clay on hillcrests)	3-10 percent	hillsides, 5,000-5,600 ft.	Blackdraw clay loam	slopewash alluvium, residuum derived from sodic shale	very deep	clay loam, clay	well drained	slow	>60 in
132	Bowbac-Hiland fine sandy loam (20% inclusions: Forkwood loam, Terro sandy loam, and rock outcrops)	3 to 10 percent	hills and hillslopes, 5,000-6,300 ft.	Bowbac fine sandy loam (40%)	slopewash alluvium, residuum derived from sandstone	mod. deep	sandy loam, clay loam	well drained	moderate	20 to 40 in
				Hiland fine sandy loam (40%)	slopewash alluvium, residuum derived from sandstone	very deep	fine sandy loam	well drained	moderate	<60 in
140	Cadoma-Renohill-Samday clay loam (5% inclusions: Silhouette clay loam)	3 to 12 percent	uplands, 5,000-6,000 ft.	Cadoma clay loam (40%)	slopewash alluvium, residuum derived from sodic shales	mod. deep	clay loam, clay	well drained	slow	20 to 40 in
				Renohill clay loam (25%)	slopewash alluvium, residuum derived from sodic shales	mod. deep	clay loam, clay	well drained	slow	20 to 40 in
				Samday clay loam (25%)	residuum from shale	very shallow	clay loam, clay	well drained	slow	<20 in
167	Cushman-Forkwood Association (15% inclusions: Cambria loam, Keyner loam, and Shingle loam)	3 to 15 percent	rolling hills and alluvial fans, 5,000-6,000 ft.	Cushman very fine sandy loam (45%)	slopewash alluvium and residuum derived from siltstone, sandstone, and shale	mod. deep	fine sandy loam, clay loam	well drained	moderate	20 to 40 in
				Forkwood loam (40%)	slopewash alluvium and residuum derived from siltstone, sandstone, and shale	very deep	loam, sandy, clay loam	well drained	moderate	>60 in

Table 3-5. Continued.

Soil Map Unit #	Map Unit Name	Slope Phase	Topography	Series	Parent Material	Depth	Predominant Texture	Drainage	Permeability	Effective Rooting Depth
178	Effington-Uffens complex (10% inclusions: Typic Torrifluvents)	0 to 6 percent	terraces and alluvial fans, 5,800-6,200 ft.	Effington silty clay loam (50%)	alluvium derived from sodic shale	very deep	silty clay loam, silty clay	well drained	slow	>60 in
				Uffens sandy loam (40%)	alluvium derived from sodic shale	very deep	sandy loam, sandy clay loam	well drained	slow	>60 in
194	Haverdad-Clarkelen complex (10%: Draknab loamy fine sand, Kishona clay loam, saline Aquic Ustifluvents, and saline Haverdad loam)	0 to 3 percent	floodplains, 4,800-6,200 ft.	Haverdad loam (55%)	alluvium derived from various sources	very deep	loam, silt loam, sandy loam	well drained	moderate	>60 in
				Clarkelen fine sandy loam (35%)	alluvium derived from various sources	very deep	fine sandy loam, loamy sand	somewhat excessive ly well drained	moderately rapid	>60 in
201	Hiland sandy loam (20 % inclusions: Bowbac sandy loam, Terro sandy loam, and Vonalee sandy loam)	0 to 6 percent	alluvial fans, 5,000-6,300 ft.	Hiland sandy loam (80%)	alluvium derived from sandstone	very deep	sandy loam, sandy clay loam	well drained	moderate	>60 in
209	Keyner-Absted-Slickspots complex (15% inclusions: Arvada clay loam, Cadoma clay loam, Orella clay loam, and Vonalee loamy sand)	0 to 6 percent	alluvial fans and low terraces, 5,000-6,200 ft.	Keyner sandy loam (50%)	sodic alluvium derived from various sources	deep	loamy sand, sandy clay loam	well drained	slow	>60 in
				Absted sandy clay loam (20%)	alluvium derived from sodic shale	very deep	sandy clay loam, clay loam, clay	well drained	slow	>60 in
				Slickspots (15%)	sodic shale	shallow	clay	poorly drained	very slow	<60 in
222	Mudray-Bributte-Birdsley complex (20% inclusions: strongly alkaline soils, rock outcrops)	6 to 30 percent	ridges and hills, 5,600-6,100 ft.	Mudray silty clay loam (35%)	residuum and slope wash alluvium derived from sodic shale	shallow	silty clay loam, clay, silty clay	well drained	very slow	10 to 20 in
				Bributte silty clay loam (25%)	residuum and slope wash alluvium derived from sodic shale	shallow	silty clay	well drained	very slow	10 to 20 in
				Birdsley loam (20%)	residuum derived from sodic shale	shallow	loam, clay loam	well drained	very slow	10 to 20 in

Table 3-5. Continued.

Soil Map Unit #	Map Unit Name	Slope Phase	Topography	Series	Parent Material	Depth	Predominant Texture	Drainage	Permeability	Effective Rooting Depth
227	Orella-Cadoma-Petrie clay loams (20% inclusions: Arvada clay loam, Silhouette clay loam, and rock outcrop)	3 to 30 percent	hills and adjacent alluvial fans, 5,000-6,500 ft.	Orella clay loam (40%)	residuum derived from sodic shale	shallow	clay loam, clay	well drained	very slow	10 to 20 in
				Cadoma clay loam (20%)	residuum and slope wash alluvium derived from sodic shale	mod. deep	clay loam, silty clay loam	well drained	slow	20 to 40 in
				Petrie clay loam (20%)	alluvium derived from sodic shale	very deep	clay loam, silty clay loam	well drained	very slow	>60 in
228	Orella-Rock Outcrop complex (20% inclusions: Cadoma clay loam and Petrie clay loam)	3 to 30 percent	hills and ridges, 5,200-6,200 ft.	Orella silty clay loam (50%)	residuum derived from sodic shale	shallow	silty clay loam, clay, silty clay	well drained	slow	10 to 20 in
				Rock outcrop (30%)	sodic shale	N/A, very shallow	silty clay	well to poorly drained	very slow	0 to 10 in
232	Persayo-Greybull association (15% inclusions: Enos loamy sand, Oceanet sandy loam, Uffens very fine sand, and Wallson loamy fine sand)	6 to 30 percent	ridges and hills, 5,700-6,200 ft.	Persayo loam (45%)	residuum and slopewash alluvium derived from siltstone and shale	shallow	loam, clay loam	well drained	moderate	10 to 20 in
				Greybull loam (40%)	residuum and slopewash alluvium derived from shale	mod. deep	loam, clay loam	well drained	moderate	20 to 40 in
270	Saddle-Griffy Association (15% inclusions: Enos loamy sand and Persayo loam)	3 to 15 percent	hills, 5,500-6,500 ft.	Saddle sandy loam (45%)	residuum and slopewash alluvium derived from sandstone and sandy shale	mod. deep	sandy loam, sandy clay loam	well drained	moderate	20 to 40 in
				Griffy fine sandy loam (40%)	alluvium derived from sandstone and sandy shale	very deep	fine sandy loam, sandy clay loam	well drained	moderate	>60 in
275	Shingle-Taluce-Rock Outcrop complex (25% inclusions: Kishona clay loam, Orella silty clay loam, Theodle clay loam, Worf sandy loam)	10 to 40 percent	escarpments and hills, 5,200-6,500 ft.	Shingle loam (30%)	residuum and slopewash alluvium derived from shale and siltstone	shallow	loam, clay loam	well drained	moderate	10 to 20 in
				Taluce sandy loam (25%)	residuum from sandstone	very shallow	sandy loam	well drained	moderately rapid	6 to 20 in
				Rock outcrops (20%)	exposed sandstone and shale	N/A, very shallow	bedrock, sand, silty sand	poorly to well drained	slow	0 to 10 in

Table 3-5. Continued.

Soil Map Unit #	Map Unit Name	Slope Phase	Topography	Series	Parent Material	Depth	Predominant Texture	Drainage	Permeability	Effective Rooting Depth
276	Shingle-Theedle Association (25% inclusions: Cushman loam, Kishona clay loam, and shallow sodic soils)	6 to 20 percent	rolling hills, 5,200-6,400 ft.	Shingle loam (40%)	residuum derived from siltstone and sandstone	shallow	loam, clay loam	well drained	moderate	10 to 20 in
				Theedle fine sandy loam (35%)	residuum derived from siltstone and sandstone	deep	fine sandy loam, loam, clay loam	well drained	moderate	20 to 40 in
282	Terro-Vonalee Association (20% inclusions: Bowbac sandy loam, Orpha sand, and Taluce loamy sand)	3 to 15 percent	rolling hills, 5,000-6,400 ft.	Terro loamy sand (50%)	slopewash alluvium derived from sandstone	mod. deep	loamy sand, sandy loam	well drained	moderately rapid	20 to 40 in
				Vonalee fine sandy loam (30%)	slopewash alluvium derived from sandstone	very deep	sandy loam	well drained	moderately rapid	>60 in
290	Uffens, thick surface-Uffens very fine sandy loams (20% inclusions: Effington clay loam and Typic Torrifluvents)	0 to 6 percent	alluvial fans and terraces, 5,800-6,200 ft.	Uffens, thick surface, very fine sandy loams (45%)	alluvium derived from sodic shale	very deep	very fine sandy loam, clay loam, loam	well drained	moderately slow	>60 in
				Uffens very fine sandy loam (35%)	alluvium derived from sodic shale	very deep	very fine sandy loam, clay loam, loam	well drained	moderately slow	>60 in
291	Uffens, runon-Typic Torrifluvents complex (20% inclusions: Effington silty clay loam and slickspots)	0 to 3 percent	terraces and floodplains, 5,200-6,300 ft.	Uffens very fine sandy loam (50%)	alluvium derived from sodic sandstone, siltstone, and shale	very deep	very fine sandy loam, clay loam	well drained	moderately slow	>60 in
				Typic Torrifluvents (30%)	alluvium derived from various sources	very deep	variable, stratified sandy loam, very fine sandy loam, loam, silt loam, silty clay loam	well drained	mod. slow to mod. rapid	>60
293	Ulm-Absted complex (10% inclusions: Cadoma clay loam and Vonalee sandy loam, and Hiland sandy loam)	0 to 6 percent	alluvial fans, 5,500-6,300 ft.	Ulm loam (60%)	alluvium derived from shale and sandstone	very deep	loam, clay loam	well drained	slow	>60
				Absted fine sandy loam (30%)	alluvium derived from sodic shale	very deep	fine sandy loam, clay loam	well drained	slow	>60 in
301	Vonalee-Hilan complex (15% inclusions: Orpha loamy sand, Forkwood sandy loam, and Bowbac sandy loam)	3 to 15 percent	stable dunes, 5,000-6,300 ft	Vonalee loamy sand (45%)	eolian deposits derived from sandstone	very deep	sandy loam, loamy sand	well drained	mod. rapid	>60 in
				Hiland sandy loam (40%)	sandstone alluvium and eolian deposits	very deep	sandy loam, sandy clay loam	well drained	moderate	>60
310	Zigweid Loam (15% inclusions: Amodac very fine sandy loam, Keyner fine sandy loam, Haverdad loam)	2 to 9 percent	alluvial terraces and fans, 5,000-6,600 ft	Zigwied loam (85%)	sandstone alluvium	very deep	fine sandy loam, loam	well drained	moderate	>60

topographic surfaces are shallow to moderately deep (20 to 40 inches). Soils on very steep slopes, on convex topographic surfaces, and/or in areas very shallow bedrock are very shallow (less than 20 inches). Most of the soils in the project area are moderately deep to deep.

<u>Predominant Soil Texture.</u> Soil texture refers to the relative amounts of clay, silt, and sand-sized particles comprising that soil. As indicated previously, soil texture is highly correlated with the particle size that comprises a given sedimentary rock. Soils derived from shale generally have sandy clay loam, clay loam, sandy clay, and loamy clay textures. Soils derived from siltstone generally have silt loam, fine sandy loam, and clay loam textures. Soils derived from sandstone have sandy loam, sandy clay loam, loamy sand, and sand textures. Soils derived from eolian deposits have sandy loam, loamy sands, and sand textures. Soils derived from slope wash, alluvium, and colluvium have a full range of textures listed previously. Most of the soils in the project area have sandy loam and clay loam textures.

<u>Drainage</u>. Drainage refers to how quickly excess moisture leaves the soil either via overland flow or infiltration and percolation. Drainage, therefore, is a function of soil texture, soil depth, topographic position, slope gradient, and the presence of a high water table. Most of the soils of the project area are well drained reflecting sandy soil textures, hillslope positions, deep soils, and the lack of a high water table. However, some of the shallow soil areas formed from shale and siltstone have poor drainage.

<u>Permeability</u>. Permeability refers to the rate at which excess soil moisture (saturation) will move through the soil. This characteristic is primarily a function of soil texture. Most of the soils in the project area have slow (0.06 to 0.20 inches/hour (in/hr)) to moderate (0.60 to 2.00 in/hr) permeabilities with smaller areas of very slow (<0.06 in/hr) and moderately rapid (2.00 to 6.00 in/hr) to very rapid (>20.00 in/hr) permeabilities.

<u>Effective Rooting Depth</u>. This parameter refers to the depth to which plants can send their roots and is a function of soil texture and soil depth. Most of the soils in the project area have effective rooting depths of 60 inches or greater. Shallower depths occur in areas where clay content is very high and in shallow soils over bedrock.

3.3.3 Soil Character Interpretations

The physical soil characteristics described above are used to interpret the soils of the project area in regard to management implications and hazard potentials such as surface runoff, water erosion, wind erosion, reclamation potential, and soil sensitivity to disturbance. Of particular concern are the ratings that infer a soil that is highly sensitive to soil disturbance caused by project development. Table 3-6 summarizes the ratings given to each of the 24 soil map units in the project area.

<u>Vegetation Cover Types and Range Site Classification</u>. Vegetation cover types mentioned in the map unit descriptions are characterized in detail in Section 3.5, Vegetation and Wetlands. Range site boundaries correlate with the soil map unit boundaries and descriptions. The BLM uses the NRCS range site descriptions (USDA-SCS 1985) in managing its vegetation resources. Range sites are distributed according to the soil map units (Figure 3-3). As indicated in Section 3.4, all

map units fall within three general range sites including High Plains Southeast, 10-14 inch precipitation zone; North Plains, 10-14 inch precipitation zone; and the Wind River basin, 5-9 inch precipitation zone. Range site textural classes include sands, sandy, shallow sandy, loamy, shallow loamy, loamy overflow, clayey, shale, impervious clay, saline upland, and saline lowland as summarized in Table 3-6. Section 3.6, Range Resources and Other Land Uses, discusses the implications and applications of range site.

Surface Runoff. Surface water runoff refers to the potential rate of overland flow caused by excess moisture at the soil surface. Surface runoff or overland flow can cause soil erosion and sedimentation which have implication on soil loss, reclamation potential of a disturbed site, impairment of water quality, and degradation of visual aesthetics. Surface runoff is primarily a function of slope gradient, soil texture, and soil depth. Most of the project area has a slow to moderate runoff potential (79 percent or 19,733 acres) given the preponderance of low slope gradients (i.e., <30%). Soils with sandy textures also generally have slow runoff potential. A smaller portion of the project area (21 percent or 5,360 acres) has moderately rapid to very rapid runoff potential in areas with clayey soils, steeper slopes, and/or shallow depths to bedrock.

Water Erosion Hazard. Water erosion hazard potential is the propensity of a soil to be eroded by overland flow and is directly related to surface runoff with an emphasis on soil texture and slope gradient. Soils with high sand and/or silt content are less cohesive such that where surface runoff hazards are moderate to very high, water erosion hazard is also moderate to severe. Soils with clay loam textures and with slow to moderate runoff potentials have slight to moderate water erosion potentials. Most of the project area (79 percent or 19,709 acres) has slight to moderate water erosion potentials while the balance (21 percent or 5,384) has moderate to severe potentials.

Wind Erosion Hazard. Wind erosion hazard potential is the propensity of a soil to be eroded by the tractive forces of wind. Wind erosion is primarily related to soil texture with silt loam, sandy loam, loamy sands, and sand textures having the greatest potential. Soils developed from eolian sand deposits and alluvium derived from sandstone and sandy shales are particularly prone to wind erosion. All of the project area has moderate to severe wind erosion hazards of which a small portion (16 percent or 3,889 acres) has a moderate potential.

Reclamation Potential. Reclamation potential refers to the ability to return disturbances to near pre-disturbance conditions and/or conditions conducive to productive soils. This hazard rating is based on an integration of several physical characteristics (slope gradient, parent material, soil texture, topsoil depth, and natural soil fertility, as well as salinity, alkalinity, and sodium content of the soil) as well as other hazard ratings (surface runoff and erosion hazards). Nineteen soil samples were collected in the project area and analyzed for various physical and chemical characteristics that relate to reclamation potential as summarized in Table 3-7. Of particular interest is the nutrient and salinity levels of the soil samples. As to be expected with a highly diverse soil environment, reclamation potential in the project area ranges from very poor to good with no areas of excellent potential. Approximately 39 percent of the project area (9,739 acres) is comprised of soil map units with a poor or worse reclamation component. Approximately 60 percent of the project area (15,116 acres) is comprised of soil map units with a fair to good reclamation potential, while the balance, one percent (242 acres), has a good potential. Soil physical characteristics and hazard ratings that equate to poor or worse potentials include slopes

Table 3-6. Summary of Range Site, Vegetation Cover Type, and Hazard Potentials of Soil Map Units.

Soil Map Unit #	Map Unit Name	Area (Acres)	% of Total Area	Range Site	Cover Type	Hazard Potential						
						Surface Runoff	Erosion		Reclamation		Sensitivity (Y,N)
							water	wind	Rating	Limitation	
112	Arvada-AbstedSlickspots Complex	1,196	4.8	loamy, imperv. clay 1	mixed desert scrub	slow	slight-moderate	moderate	fair to good	salinity, alkalinity, high clay content	N
117	Badlands	248	1.0	N/A	badlands	mod. slow to very rapid	very high	moderate	very poor to poor	steep slopes, shallow topsoil, erosion	Y
124	Blackdraw clay loam	497	2.0	saline upland 1	mixed desert scrub	med.	moderate	moderate	fair	high clay and sodium content	Y
132	Bowbac-Hiland fine sandy loams	580	2.3	loamy 1	mixed desert scrub	slow to med.	slight to moderate	severe	fair	severe wind erosion, high sand content	N
140	Cadoma-Renohill-Samday clay loams	240	1.0	clayey, imperv. clay, shale 1	mixed desert scrub	slow to med.	slight to moderate	moderate	fair	steep slopes, shallow topsoil, and high alkalinity, salinity, and sodium content	N
167	Cushman-Forkwood association	563	2.2	loamy 1	mixed desert scrub	slow to med.	slight to moderate	moderate to severe	fair to good	wind erosion	N
178	Effington-Uffens complex	682	2.7	Imperv. clay, saline lowlnd,loamy 3	mixed desert scrub	slow	slight	moderate to severe	fair	wind erosion, and high alkalinity, salinity, and sodium content	Y
194	Haverdad-Clarkelen complex	3	<0.1	loamy, loamy over-flow, saline lowlnd 1	mixed desert scrub	slow	slight	moderate to severe	fair to good	wind erosion	N
201	Hiland sandy loam	5,580	22.2	loamy 1	mixed desert scrub	slow	slight	severe	fair to good	wind erosion	N

Table 3-6. Continued.

Soil Map Unit #	Map Unit Name	Area (Acres)	% of Total Area	Range Site	Cover Type	Hazard Potential						
						Surface Runoff	Erosion		Reclamation		Sensitivity (Y,N)
							water	wind	Rating	Limitation	
209	Keyner-Absted-Slickspots complex	4,810	19.2	loamy 1	mixed desert scrub	slow	slight to moderate	moderate to severe	poor to good	clay content, sodium, salinity, alkalinity, wind erosion	Y
222	Mudray-Bributte-Birdsley complex	285	1.1	saline upland 3	mixed desert scrub	rapid	severe	moderate	poor to fair	erosion, shallow topsoil, and salinity, alkalinity, and clay content	Y
227	Orella-Cadoma-Petrie clay loams	134	0.5	imperv. clay 1	mixed desert scrub	med. to rapid	moderate to severe	moderate	fair	erosion, shallow topsoil, and salinity, alkalinity, and clay content	Y
228	Orella-Rock Outcrop complex	746	3.0	imperv. clay 1	mixed desert scrub	rapid	severe	moderate	poor to fair	bedrock outcropp-ing, erosion, shallow topsoil, and salinity, alkalinity, and clay content	Y
229	Orpha loamy sand	24	<0.1	sands 2	mixed desert scrub	med.	severe	severe	fair	sand, erosion	Y
232	Persayo-Greybull association	301	1.2	shallow loamy, loamy 3	mixed desert scrub	med. to rapid	moderate to severe	moderate	fair	shallow topsoil, erosion	Y
270	Saddle-Griffy association	97	0.4	loamy 3	mixed desert scrub	slow to med.	slight to moderate	severe	fair to good	erosion	N
275	Shingle-Taluce-Rock Outcrop complex	3,365	13.4	shallow sandy, shallow loamy 1	mixed desert scrub	rapid	severe	moderate to severe	very poor to fair	shallow topsoil, bedrock outcropp-ing, severe erosion	Y

Table 3-6. Continued.

Soil Map Unit #	Map Unit Name	Area (Acres)	% of Total Area	Range Site	Cover Type	Hazard Potential					Sensitivity (Y,N)
						Surface Runoff	Erosion		Reclamation		
							water	wind	Rating	Limitation	
276	Shingle-Theedle association	285	1.1	loamy, shallow loamy 1	mixed desert scrub	med. to rapid	moderate to severe	moderate to severe	poor to good	shallow topsoil, erosion	Y
282	Terro-Vonalee association	199	0.8	sandy 1	mixed desert scrub	slow	slight to moderate	severe	fair to good	sand, erosion	Y
290	Uffens thick surface-Uffens very fine sandy loams	263	1.0	loamy, imperv. 3	mixed desert	slow	slight	severe	fair to good	erosion, and salinity, alkalinity, and clay content	N
291	Uffens-runon Typic Torrifluvents complex	345	1.4	saline lowlnd 3	mixed desert scrub	slow	slight	severe	fair to good	erosion, and salinity, alkalinity, and sodium content	Y
293	Ulm-Absted complex	54	0.2	loamy 1	mixed desert scrub	slow	slight	moderate to severe	fair to good	erosion, and salinity, alkalinity, and sodium content	N
301	Vonalee-Hiland complex	4,358	17.5	sandy, loamy 1	mixed desert scrub	slow to med.	slight to moderate	severe	fair to good	erosion, sand	Y
310	Zigweid loam	242	1.0	loamy 1	mixed desert scrub	med.	moderate	moderate	good	sand	N
TOTAL AREA		25,093	100.0								

Range Sites:
1 - High Plains Southeast, 10-14 inch preciptation zone.
2 - North Plains, 10-14 inch precipitation zone.
3 - Wind River Basin, 5-9 inch precipitation zone

Table 3-7. Results of Laboratory Analysis of Topsoil Samples[1].

Map Unit	No. of Samples	Area (ac)	Parameters Analyzed						
			Texture	pH	Salinity EC (mmhos/cm)	Phosphorous (ppm)	Potassium (ppm)	Nitrate-Nitrogen (ppm)	Lime (estimated)[2]
112	1	1,196	silt loam	6.8	0.3	15	180	1.8	+
117	1	248	clay	5.1	2.5	12	165	<1.0	0
124	1	497	loam	8.2	0.4	3.5	303	0.6	+
132	1	580	sandy loam	6.3	0.5	4.2	131	<1.0	0
178	1	682	loam	8.3	0.5	5.7	132	1.9	+
201	2	5,580	silty clay sandy loam	7.6	0.35	8.8	3.73	2.0	++
209	3	4,810	clay loam silt loam loam	7.6	0.57	4.6	184	4.7	++
228	1	746	sandy loam	6.7	0.3	2.1	177	<1.0	0
275	3	3,365	sandy loam silty clay loam loam	7.8	0.6	4.8	106	1.6	++
291	1	345	sandy loam	7.9	0.2	4.7	137	0.4	+
301	4	4,358	sandy loam loam	7.2	0.3	6.8	167	1.1	++
(n=11)	(n=20)	22,407 89%							

1 - Values averaged for map unit samples where applicable.
2 - Estimation of lime was qualitative, 0 = no lime, + = some lime, and ++ = a lot of lime.

greater than 30 percent, high clay content, high sand content, shallow depth to bedrock, rapid and very rapid surface runoff, severe water erosion, severe wind erosion, and soils with high alkalinity, salinity, and sodium content. High salinity and alkalinity contents reduce the number of species and areal cover of such plants to cover and protect the soil, thus rendering the soil more sensitive to disturbance and reducing reclamation potential. Sodic soils with high sodium contents (highly charged with sodium ions) soil causes the physical structure of the soil to break down. This results in very slow permeability, rapid runoff, severe hazard of water erosion, and a shallow rooting depth (10 to 20 inches), thus also rendering the soil more sensitive to disturbance and reducing reclamation potential. Most disturbances (i.e. reclaimed pipeline ROWs) observed in the project area showed effective revegetation in regard to surface runoff, erosion, and sedimentation control and a cover of beneficial plant species. Revegetation on areas of poor revegetation potential would be feasible with the application of best management practices if such areas could not first be avoided. More detailed information concerning reclamation potential is contained in the Soils, Water, and Vegetation Resources Technical Report (ECOTONE 1997).

Sensitive Soils. Using the criteria outlined in the *National Soil Survey Handbook* (USDA-SCS 1993) to evaluate physical soil character (Table 3-5) and hazard potentials (Table 3-6), soils of the analysis can be characterized as sensitive and non-sensitive to project development activities. Sensitive soils are identified in Table 3-6 and include approximately 65 percent of the project area, or 16,279 acres, as shown in Figure 3-5. Most of the sensitive soils have rapid to very rapid surface runoff, severe water and wind erosion, and poor reclamation potential. The sensitive soils in the project area have features which restrict reclamation potential and revegetation and stabilization of sensitive soils can be very difficult and expensive. When these soil characteristics are combined with steep slopes, the potential for severe erosion and stabilization failure are increased. Final reclamation success is dependent on more than the physical and chemical soil properties. Soil handling techniques, erosion control practices, seeding methods, and climatological conditions all influence reclamation failure or success. Therefore, these characteristics restrict the soil's capability of sustaining disturbance associated with land development. As discussed in greater detail in Chapter 4, sensitive soils should either be totally avoided or special attention to mitigating and/or remediating unavoidable adverse impacts may be required.

3.3.4 Soil Characteristics with Management Implications

The BLM has mapped areas within the Platte River Resource Area that have particular management implication due to shallow soils, steep slopes, high wind and water erosion, and entrenched gullies (USDI-BLM 1984a). The BLM (USDI-BLM 1984a) has classified the general project area as having no watershed-soil restrictions. However, review of management of sensitive soils in the PRRA suggests that the areas identified as sensitive on Figure 3-5 should have been identified as having watershed-soil restrictions in the PRRA RMP. The northern and northeastern portions associated with MU 275 and 117 have slopes ranging from 15 to 25 percent. However, inspection of that portion indicated slopes in excess of 25 percent (USDI-BLM 1995). High rates of natural or geologic erosion were evident as well as accelerated erosion as evidenced by deep gullies and rilling. The northern portion of the project area also falls within the boundary of the Cave Gulch sensitive drainage (USDI-1984a).

Table 3-8. Summary of Existing Disturbance in the Project Area[a].

Disturbance Class	Total Length (ft)	Construction Disturbance		Long-Term Disturbance	
		Width (ft)	Area (ac)	Width (ft)	Area (ac)
Disturbance as of June 7, 1996 photography					
Highway	26,400	120	72.7	75	45.5
County Road	46,347	60	63.8	40	42.6
Collector Roads	0	52	0	28	0
Local Roads	40,284 (17,600[b])	48	44.4	24	12.5[b]
Resource Roads	69,227	40	63.6	16	25.4
Two-Track Roads	809,849	6	111.6	6	111.6
Fencelines, Livestock Tracks/ Seismic Lines	298,169	4	27.4	4	27.4
Railroad	43,608 (22,879[c])	100	100.1	75	35.7[c]
Pipelines, - isolated - w/Roads	195,167 18,969	60 30	268.8 13.1	0 0	0 0
Well Sites (31)	31 @ 2.75		85.3	31@1.5	46.5
Urban/Industrial			80.0		80.0
SUBTOTAL			**930.8**		**427.2**
Disturbance June 7 through October 1, 1996					
Resource Roads	9,504	40	8.7	16	3.5
Pipelines, -isolated -w/roads	45,070 9,504	60 30	62.1 6.6	0 0	0 0
Well Sites (9)	9 @ 2.75		24.8	9 @ 1.5	13.5
Ancillary Facilities	8.0		8.0	8.0	8.0
SUBTOTAL			**110.2**		**25.0**
TOTAL DISTURBANCE			**1,041**		**452.2**

a - see ECOTONE (1997).
b - assumes 17,600 feet of abandoned old highway is revegetated in the long term; therefore, 22,684 feet of existing local road disturbance would remain in the long-term.
c - assumes 22,879 feet of abandoned railroad is revegetated in the long term; therefore, 20,729 feet of existing railroad disturbance would remain in the long-term.
d -Includes 4,000 feet of Pony Express and 41,070 feet of Express pipelines.

3.3.5 Soil Samples

Nineteen soil samples were collected from randomly located sites in the project area and analyzed for various physical and chemical characteristics to verify the existing information base on soils and gather specific data that relate to reclamation potential and soil sensitivity to development activities. Table 3-7 summarizes the results of the topsoil sample analysis. There was relatively good correlation between the map unit descriptions and soil sample analysis results. Considering the inherent variability in soil texture possible within a map unit, differences in texture from the general map unit description are expected. As indicated in Table 3-7, the soil samples came from soil map units covering 89 percent of the project area, or 22,407 acres. Thus, the samples represent most of the soil conditions in the project area.

Overall, sampled soils within the project area have very low nutrient levels. This may be in large part due to the sandy nature of the soils and the relatively scant native vegetal cover. Levels of available nitrogen and phosphorous are low. Potassium levels are generally adequate. Soil pH is generally adequate in the neutral range, with no indications of excessive salinity or alkalinity problems. The high lime content in some samples indicates that the soil has a high capacity to buffer against changes in pH. As expected, soils with minimal lime are slightly acidic while soils with more lime are neutral to slightly basic. Nine of the soil samples were also analyzed for selenium content. All selenium levels were below the minimum detection threshold level. Thus, based on these nine samples, selenium is likely not a plant growth, livestock nutrition, or environmental health concern in the project area. These results generally correlate with the previous interpretation of reclamation potential; that is, approximately 61 percent of the project area or 15,358 acres, has a fair or better reclamation potential. Based on the results of soil analyses, application of fertilizer would be needed to compensate for nutrient deficiencies and for establishment and growth of native grasses in the project area.

3.3.6 Existing Disturbance

The project area is not pristine. The area has been subjected to various human-caused disturbances such as those listed in Table 3-8. As itemized in Table 3-8, the total existing disturbance within the 25,093-acre project area is approximately 1,041 acres or 4.1 percent of the area. Of this total, only 452 acres are likely to be left unvegetated since they are being used for permanent facilities. The balance of this disturbance, 589 acres, is in various stages of revegetation and reclamation. Based on observations of successful revegetation efforts in the project area, adequate revegetation and reclamation are feasible. Of this total disturbance, approximately 633 acres has occurred in areas containing sensitive soils. Existing disturbance is discussed in greater detail in Chapter 5, Cumulative Impacts, as well as in the Soils, Water, and Vegetation Resources Technical Report (ECOTONE 1997). Existing disturbance is distributed according to watershed in these other technical sections. Most of this disturbance has occurred in the Waltman Draw and Cave Gulch drainages.

Although the total area of disturbance is in varying stages of rehabilitation and revegetation, such disturbance has contributed to accelerated erosion in the project area. Erosion cannot be accurately estimated due to the highly dynamic factors involved (e.g., slope gradients, reclamation, soil type, vegetal cover, transient nature of revegetation, etc.). However, the Modified Soil Loss

Equation (MSLE) can be used to estimate general magnitudes of erosion resulting from the existing disturbance. Erosion estimates were made for this project following Grah (1989), Israelsen et al. (1980), USDA-FS (1980), and Wischmeier and Smith (1965). Using these procedures as summarized in the Soils, Water, and Vegetation Resources Technical Report (ECOTONE 1997), baseline or natural erosion in the project area is approximately 1.5 tons/acre/year or 37,640 tons/year. Assuming inadequate revegetation, accelerated erosion from existing disturbances (1,041 acres) is approximately 5 tons per acre per year, or 5,205 tons per year. This represents an approximate increase in total erosion of 11 percent over baseline or natural conditions. This represents a worse-case estimate; the true natural baseline erosion rates are likely less than the value presented here. Most of the eroded soil is contained on-site and is not transported off-site to streams due to low overland flow transport efficiencies (i.e., less than 10 percent). The cumulative effect of existing disturbance combined with proposed and future disturbance is discussed in greater detail in Chapter 4.

Livestock grazing has contributed to the level of disturbance described above through removal of vegetal cover and soil compaction. These factors contribute to increased erosion above the natural baseline rate. Not enough is known about the intensity of grazing experienced by the project area to predict an increase in soil erosion as accomplished above for other disturbances. However, erosion increases attributable to livestock grazing is well below the estimate provided previously in this discussion.

3.4 WATER RESOURCES

Both surface and groundwater resources are present in the project area. Surface water includes numerous intermittent and ephemeral streams, livestock ponds, small detention reservoirs, and seeps and springs. Groundwater resources include free water contained within porous or fractured bedrock that could be utilized for culinary, agricultural, and industrial purposes. Therefore, the occurrence and distribution of water resources in the project area are dependent on climate and structural geology (discussed previously under Geology, Section 3.1). The northeastern extent of the project area falls within the boundary of the Cave Gulch sensitive drainage (USDI-1984a).

3.4.1 Precipitation and Climate

The project area occurs in a continental dry, cold-temperate-boreal climate (Trewartha 1968). This climate is primarily characterized by a deficiency of precipitation (i.e., evaporation exceeds precipitation). The area generally has cold temperatures where fewer than eight months have an average temperature greater than 50°F, with hot summer days and cool summer nights, but bitterly cold winters. The closest recording weather station to the project area is located in Casper approximately 50 miles to the east (Martner 1986).

The average annual temperature is 42°F. The average daily low and high temperatures in January are 8°F and 30°F, respectively. In contrast, the average daily low and high temperatures in July are 52°F and 86°F, respectively. The average number of days per year with a minimum temperature at or below 32°F is 200 days and the average number of days per year with a maximum temperature at or above 90°F is 20 days.

Average precipitation is between 10 and 14 inches. Precipitation occurs throughout the year with a peak in May. The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the 50-year, 24-hour precipitation rate is 2.6 inches generated by thunderstorm events. Average annual snowfall depth is approximately 40 inches. Greatest snowfall usually occurs in March and April. Due to the effect of ablation and snow drifting, a discontinuous snow cover is usually present during the winter.

Mean annual evaporation ranges from 45 inches (lake) to 70 inches (pan) and potential evaporation is 21 to 23 inches as compared to the mean annual precipitation of 10 inches (Martner 1986). This gives an annual deficit of approximately 12 inches. These meteorological and climatological characteristics of the project area combine to produce a predominantly dry climate where evaporation exceeds precipitation.

3.4.2 Surface Water

The project area straddles the divide between headwater tributaries of the South Fork of the Powder River and the Wind River. Watersheds of nine drainages cover the project area as shown on Figure 3-5 and as summarized in Table 3-9. The northwest portion of the project area is drained by headwaters of Alkali Creek, a major tributary to Badwater Creek and subsequently into Boysen Reservoir on the Wind River west of the project area. The Wind River is a tributary of the Big Horn River which flows into the Yellowstone River, a tributary of the Missouri River, which subsequently flows into the Mississippi River. The Alkali Creek watershed covers approximately 1,801 acres of the project area. The west-central portion of the project area is drained by headwaters of Poison Creek, a major tributary to Boysen Reservoir. The Poison Creek watershed covers approximately 4,198 acres of the project area. The northeast and east central portions of the project area are drained by three forks of Cave Gulch including the North Branch of Cave Gulch (3,455 acres), Cave Gulch (3,012 acres), and the South Branch of Cave Gulch (2,735 acres). Cave Gulch flows into the South Fork of the Powder River, which is tributary to the Yellowstone River, etc. Combined, the Cave Gulch watersheds cover 9,202 acres of the project area. The southern portion of the project area is drained by Sand Draw tributaries including Waltman Draw (4,209 acres), Keg Spring Draw (582 acres), upper Sand Draw (3,074 acres), and unnamed tributaries of Sand Draw (2,027 acres). Combined, the Sand Draw watersheds cover 9,892 acres of the project area. Sand Draw flows into the South Fork of the Powder River.

There are approximately 337,335 linear feet of drainage channels in the project area as indicated on USGS topographic quadrangles and National Wetland Inventory (NWI) maps. Of this total, approximately 277,465 feet exhibit an ephemeral flow regime, while the balance, 59,870 feet, exhibit an intermittent flow regime. Ephemeral flow is defined by erratic flow in response to direct precipitation events, snowmelt, and overland flow. Under this regime, the flow generally will last for a short period after the runoff generating event. Intermittent flow is characterized by more continuous flow during the year in response to interflow, subsurface flow, and shallow groundwater flow. Generally intermittent flow occurs for a longer period after the event and occurs relatively consistently within a year and from year to year. Intermittent flow can be further defined based on the flow in space (i.e., position of flow along the channel) or in time (i.e., occurrence of flow during the year). Most intermittent channels in the project area exhibit variable flow in time and space. Most of the ephemeral channels are vegetated swales that do not exhibit mineral channels.

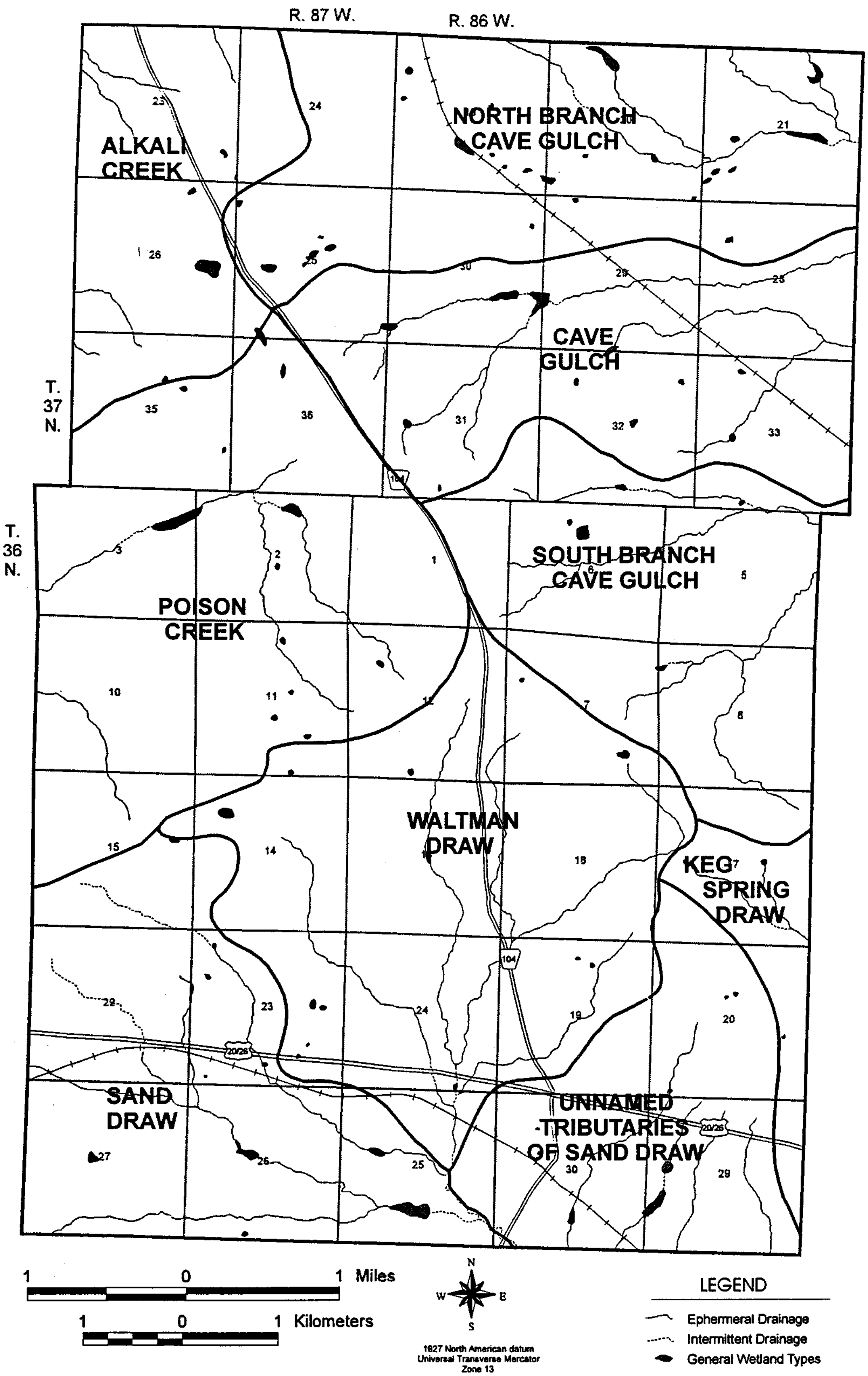


Figure 3-5. Watershed Boundaries, Stream Channels, and Other Water Features in the Project Area.

Table 3-9. Summary of Watershed Area and Length of Stream Channel by Flow Regime for the Project Area.

River Basin	Tributary	Area (ac)	Flow Class	Length (ft)
Wind River	Alkali Creek	1,801	Ephemeral Intermittent **Total**	13,690 0 **13,690**
	Poison Creek	4,198	Ephemeral Intermittent **Total**	34,220 4,890 **39,110**
South Fork Powder River	**Cave Gulch**			
	North Branch	3,455	Ephemeral Intermittent **Total**	21,510 8,800 **30,310**
	Main Branch	3,012	Ephemeral Intermittent **Total**	38,135 12,710 **50,845**
	South Branch	2,735	Ephemeral Intermittent **Total**	41,460 3,520 **44,980**
	Total	**9,202**	**Ephemeral** **Intermittent** **Total**	**101,105** **25,030** **126,135**
	Sand Draw			
	Waltman Draw	4,209	Ephemeral Intermittent **Total**	55,535 5,085 **60,620**
	Upper Sand Draw	3,074	Ephemeral Intermittent **Total**	40,245 21,355 **61,600**
	Sand Draw Tributaries	2,027	Ephemeral Intermittent **Total**	25,430 2,930 **28,360**
	Keg Spring Draw	582	Ephemeral Intermittent **Total**	7,240 580 **7,820**
	Total	**9,892**	**Ephemeral** **Intermittent** **Total**	**128,450** **29,950** **158,400**
TOTAL PROJECT AREA		**25,093**	**Ephemeral** **Intermittent** **Total**	**277,465** **59,870** **337,335**

Many of the drainage channels of the Cave Gulch watersheds are deeply incised showing high rates of natural baseline erosion and/or accelerated erosion caused by human disturbance. In addition, these channels have relatively steep channel gradients and drain relatively steep areas further causing the channels to incise. Most of the drainage channels of the other watersheds have relatively shallow gradients, drain relatively flat to gently sloping land surfaces, are not deeply incised, and show reduced rates of baseline erosion and/or accelerated erosion. There are no streamflow data for the project area (WRDC 1996). The closest gaging station on Cave Gulch is located approximately 6 miles east of the project area. Infrequent and irregular flow within the stream channels correlates with the dynamics of precipitation events; surface runoff occurs during spring and early summer as a result of snowmelt and rainfall (Lowham et al. 1985). Streams receive little to no support from groundwater discharge; thus, there are extended periods where drainages contain no flows. Mean annual runoff likely ranges from 0.5 to 2.0 inches per year.

Most of the project area has soils with relatively high infiltration and permeability rates. Therefore, little surface runoff is generated during most low intensity precipitation events with most excess surface moisture infiltrating the soil surface and percolating to depths well below stream channels. *The Wyoming Water Atlas* (Wyoming WRDS 1990) indicates that surface water yield from watersheds in the vicinity of the project area is approximately 0.5 inches per year. This is in contrast to mean annual precipitation of approximately 10 to 14 inches. Therefore, the vast majority of free water reaching the soil surface either is evapotranspired back to the atmosphere or infiltrates and percolates to the water table with only a small portion of precipitation running off on the soil surface. The exception to this generalization occurs in the steeply sloping lands in the northeastern and east-central portions of the project area where consolidated sandstone, shale, and clays are exposed. These surfaces have very slow infiltration rates which, combined with steep slopes, can produce rapid stream flow response to precipitation events. In addition, the incidence of surface runoff generation is greater from disturbed areas such as roads, drill/well sites, etc., where the vegetation has been removed, topsoil graded, and subsoils compacted. Thus, increased surface runoff likely occurs on the 1,041 acres of existing disturbance in the project area.

High infiltration and permeability rates restrict the soil's suitability for unlined reserve pits. As discussed in greater detail in Chapter 4, Environmental Consequences, soils with high permeability rates can lead to reserve pit seepage and possible contamination of surface and groundwater if such pits are unlined.

As indicated previously, most channels exhibit only ephemeral flow from direct precipitation associated primarily with high intensity, short duration, summer thunderstorms. Such events are highly erratic in time and space in the project area. Surface runoff generation may be insufficient in many watersheds to produce frequent enough stream flow for an active channel to be developed and maintained. In other words, most of the drainages in the project area are more accurately described as vegetated swales, lacking active channels that are characterized as having mineral beds and observable fluviogeomorphic characteristics such as channel beds, bars, point bars, active floodplains, etc. Even though annual watershed yield is quite low as described above, this runoff may occur over a short period of time with sufficient concentrated water to develop stream channels. Given a specific stream, a channel may intergrade between an active channel and a vegetated swale.

Based on information provided by the Wyoming State Engineer's Office (SEO 1996), there are 16 surface water right permits on file that occur within the project area. Six of the permits are unadjudicated, five are adjudicated, four are good standing, and one is expired. These surface water rights are all located on various drainage channels in the project area. Most of the rights are associated with livestock watering facilities (i.e., stock ponds); however, two rights are associated with domestic use. These permit rights total to 587.4 acre-feet per year.

Executive Order 11988 requires federal agencies to make decisions in a manner that promote avoidance of adverse impacts and reduce the risk of property loss and human safety due to floodplains development/modification and preserves the natural and beneficial values of floodplains. Based on field inspection of the project area, few if any of the drainage channels in the project area have active floodplains associated with their channels. This is due to the ephemeral and erratic nature of surface runoff where channel forming processes are not consistent enough to form active floodplains (in the fluviogeomorphic sense) and/or the drainages are vegetated swales with no mineral channel beds exposed. However, all channels, either active or vegetated, transport excess surface water and therefore, have floodways (in the fluviogeomorphic sense). No Federal Emergency Management Act (FEMA) mapping has been accomplished within the area to identify floodplains or designate flood hazard areas. Flooding generally occurs in response to high intensity, localized storms. Such storms initiate most of the floodwater damage, surface erosion, arroyo or gully formation, and sediment deposition in arid and semi-arid environments (Branson et al. 1981).

Several drainage channels within the project area have been diked to impound water primarily for livestock. Approximately 25 such impoundments on channels have been identified in the project area. Water levels within the impoundments are not stable and depend on the erratic and infrequent ephemeral runoff events.

There were no surface water quality data available for the project area (WRDC 1996). However, based on professional training and experience with analyzing surface water quality in Wyoming and other semi-arid regions, surface water quality likely changes with seasons and the magnitude and source of discharge. In semiarid regions, surface waters typically have a relatively high concentration of dissolved-solids. In general, surface water, when present in the project area, is expected to be of poor to fair quality in regard to culinary and industrial uses due to high turbidity, suspended solids, dissolved solids, and salinity.

No known point sources of pollution have been documented in the project area; however, oil and gas development and other industrial activities in the Platte Resource Area have been documented to be a potential source of point-source water quality reduction (USDI-BLM 1984b). Planned discharge of point sources of pollution must be covered by a National Pollutant Discharge Elimination System (NPDES) permit. Numerous NPDES permits have been issued in the Platte River Resource Area for mining, oil and gas, and industrial development. However, unplanned discharges cannot be predicted, and no NPDES permits are applicable. If such sources have been discharged, they likely arose from improbable accidents and are of limited areal and temporal extent.

The primary non-point pollution source is natural or geologic erosion, accelerated erosion from livestock grazing, and oil and gas exploration and development. Grazing, oil and gas and other mining developments, and poor road construction may further increase the naturally high erosion rates described in the Soil section. However, disturbance due to soil grading activities and vehicle use amounts to 4.2 percent of the project area, which represents a relatively small area.

Information developed by the USDI-BLM (1994) pursuant to the Colorado River Basin Salinity Control Initiative for similar areas south of the project area, suggests that baseline or natural sediment may be produced or delivered to a point along the stream channel at an approximate rate as high as 1.0 acre-feet per square mile per year. This volume equates to approximately 0.017 inches per year or 4 tons per acre per year of sediment production. These rates are indicative of the trend towards channel degradation. In other words, most of this sediment originates from channel erosion as compared to sediment inflow from soil erosion on the land surface.

All streams within the project area are Class 5 streams from a fisheries perspective (incapable of supporting fish) (WGFD 1991) and are Class 4 (surface waters other than Class 1 which are determined to not have the hydrologic or natural water quality potential to support fish) in regard to water quality (WDEQ 1990).

3.4.3 Groundwater

The project area occurs on the boundary of the Wyoming Basins and the Northern Great Plains (USGS 1983 and 1984). More specifically, the area is along the boundary of the Wind River Basin and the Casper Arch. Whitcomb and Lowry (1968) described the hydrology of the Wind River Basin and Crist and Lowry described the groundwater resources of Natrona County which includes the Casper Arch. Groundwater resources include deep and shallow and confined and unconfined aquifers. Aquifers in this area consist mainly of sandstone. Well yields are highly variable in the analysis and surrounding areas and range from 5 to 100 gallons per minute. Transmissivities and hydraulic conductivities have not been estimated in the project area nor in the surrounding area. Whitcomb and Lowry estimated specific capacities of the Wind River and Fort Union formations in the Wind River Basin to range from 0.02 to 2.25 gallons per minute per foot of drawdown. Most of the aquifers are confined and occur in lenticular and interbedded rock sequences that are complexly folded and faulted. Water is primarily contained within pores in consolidated rock and secondarily, in fractures.

The project area is a potential recharge area for the Casper Arch and the eastern Wind River Basin. Rocks exposed on these two areas allow surface water infiltration and percolation into the aquifers. Rocks of the Tertiary Fort Union and Upper Cretaceous Lance and Mesaverde formations crop out on the Casper Arch, northeast of the trace of the Casper Arch Thrust. Rocks of the Tertiary Wind River Formation crop out in the eastern part of the Wind River Basin, northeast of the trace of the Casper Arch Thrust. Because the project area is in a recharge zone, management of existing sources of groundwater pollution is critical to maintaining good water quality down-gradient. The occurrence of water in the project area is typical of the semiarid Wyoming Basins. Sandstones of Tertiary and Upper Cretaceous formations are the best aquifers within the analysis and the surrounding areas.

However, the rocks in the project area exposed on the Casper Arch have limited extent owing to their lenticular nature and the complex folding and faulting which has occurred. Because the

Casper Arch Thrust acts as a barrier to groundwater flow, recharge to these rocks is local and does not enter the deeper aquifers. Therefore, the groundwater potential is poor. In contrast the rocks in the project area exposed southwest of the Casper Arch Thrust have a much wider extent. Recharge to these rocks enter the eastern Wind River Basin regional flow system and may recharge the deeper aquifers. Therefore, the groundwater potential is fair to good.

There are few springs and seeps in the project area. The few seeps and springs that occur are located along ephemeral and intermittent drainage channels or immediately downstream of stock-watering detention ponds (USDI-BLM 1995). Seeps and springs are most likely to occur in the aquatic habitat areas identified on Figure 3-6 in Section 3.5, Vegetation and Wetlands.

The USGS Ground Water Site Inventory provides information on three wells within the project area (WRDC 1996). Data is incomplete for one well and scant for two wells and show water levels at 8.3 feet and 34.8 feet. No water quality data were available for either well. The SEO (1996) has records for eighteen groundwater right permits on file. Two of the permits are adjudicated, three are abandoned, six are canceled, and seven have unknown status. Only nine of these wells have records for static water depth and yield. Water depths range from 10 to 237 feet and well yields range from 0 to 30. In general, the shallowest water level and greatest yield occur in wells located in or near alluvial aquifers. Uses included domestic, stock watering, temporary, monitoring, and miscellaneous.

Groundwater quality is variable in the project area and relates to the depth of the aquifers and the rock type. The best available indicator of the quality of groundwater for the area is total dissolved solids (TDS). Groundwater contained in Tertiary and Upper Cretaceous aquifers generally have TDS ranging from 1,000 to 5,000 mg/l but are usually below 3,000 mg/l TDS with calcium, sodium, sulfate, and bicarbonate the predominant ions. A water analysis report on file with the SEO for the adjudicated well indicated 1,298 mg/l of TDS, a salt (NaCl) equivalent of 1,036 mg/l, and an observed pH of 8.2. Total hardness as calcium carbonate was 24 mg/l. Levels of sodium, sulfate, and bicarbonate were 331 mg/l, 666 mg/l, and 339 mg/l, respectively. The analysis concluded that sodium, sulfate, and TDS exceeded the recommended maximum and that the water was not recommended for domestic use.

3.5 VEGETATION AND WETLANDS

The project area occurs in the broad zone between the Great Basin and Great Plains floristic provinces (Dorn 1992). Plant species from both provinces are present because the boundary is broad and poorly defined. Vegetation correlates with the Grassland (Interior Grassland Plains) and Desert and Basin vegetation zones described by Porter (1962). Because the annual precipitation ranges from 10 to 14 inches (Martiner 1986, USDA-SCS 1985), plants are primarily drought-tolerant low shrubs, tall and short grasses, and flowering herbs.

3.5.1 Vegetation Cover Types

The project area contains three general vegetation cover types: mixed desert scrub, badlands, and aquatic habitats. Figure 3-6 depicts their occurrence and distribution in the project area. Variability of vegetation composition is high within each of these types. Within the mixed desert scrub type, areas may be dominated by upland grasses and forbs with minimal shrubs, while in low areas associated with larger drainages, the alkali scrub sub-type comprised of saline and alkaline tolerant species may dominate. The alkali bottomlands sub-type occurs in very small units that cannot be shown on Figure 3-6. Therefore, areas of this subtype are incorporated into the general mixed desert scrub type. Three general range sites correlate with the vegetation of the project area and include the High Plains Southeast, Northern Plains, and Wind River Basin sites.

Mixed Desert Scrub. Shrubs in the project area are drought-tolerant. The primary shrub on areas with good soil development is big sagebrush (*Artemisia tridentata*). Where soil development is poor and/or where soils are more alkaline, shrubs include black sagebrush (*A. nova*), fringed sagebrush (*A. frigida*), low sagebrush (*A. arbuscula*), birdfoot sagebrush (*A. pedatifida*), Gardner saltbush (*Atriplex gardneri*), prickly phlox (*Leptodactylon pungens*), short species of rabbitbrush (*Chrysothamnus* spp.), greenmolly (*Kochia americana*), shadscale (*Atriplex confertifolia*), and spiny hopsage (*Grayia spinosa*). Depending on the condition of the vegetation, plains pricklypear (*Opuntia polyacantha*) is an infrequent to common component. Grassy knolls and intershrub areas within this cover type contain shortgrass plains grasses and forbs. The dominant grasses include blue grama (*Bouteloua gracilis*), Indian ricegrass (*Oryzopsis hymenoides*), junegrass (*Koeleria macrantha*), muttongrass (*Poa fendleriana*), Sandberg bluegrass (*P. secunda*), needle-and-thread (*Stipa comata*), threadleaf sedge (*Carex geyeri*), and several types of wheatgrass (e.g., *Agropyron smithii, A. spicatum, A. trachycaulum*). Forbs include spoonleaf milkvetch (*Astragalus spatulatus*), Hooker sandwort (*Arenaria hookeri*), both low-growing, cushion plants, and Hoods phlox (*Phlox hoodii*).

Where the vegetative condition deteriorates, big sagebrush, birdfoot sagebrush, blue grama, junegrass, Sandberg bluegrass, silver sagebrush, rabbitbrush, and threadleaf sedge increase and annuals such as cheatgrass invade and become established. This cover type (including the alkali bottomland sub-type) occupies approximately 21,452 acres or 85.5 percent of the 25,093-acre project area.

Alkali Bottomlands. In alkaline to highly alkaline soils of bottomland areas as well as in saline depressions, the primary shrubs are greasewood (*Sarcobatus vermiculatus*) and Gardner saltbush. Other species include budsage (*Artemisia spinescens*), silver sagebrush (*A. cana*), and low rabbitbrush (*Chrysothamnus viscidiflorus*). The dominant forbs and grasses are inland saltgrass (*Distichlis spicata*), western wheatgrass, aster (*Aster* spp.), and seepweed (*Suaeda* spp.). This sub-type of the mixed desert scrub vegetation cover type occupies approximately 248 acres or about 1 percent of the project area.

Badlands. Badland areas consist of rock outcrops and highly eroded, dissected slopes, where severe soil, moisture, and climatic conditions inhibit the development of vegetation. This cover type, however, is seldom totally barren. Vegetation includes low-growing and cushion plants such as Gardner saltbush, low rabbitbrush, stemless goldenweed (*Haplopappus acaulis*), moss phlox (*Phlox bryoides*), fringed sagebrush, birdfoot sagebrush, and gumweed aster (*Macheranthera grindeloides*). This cover type occupies approximately 3,383 acres or 13.5 percent of the project area.

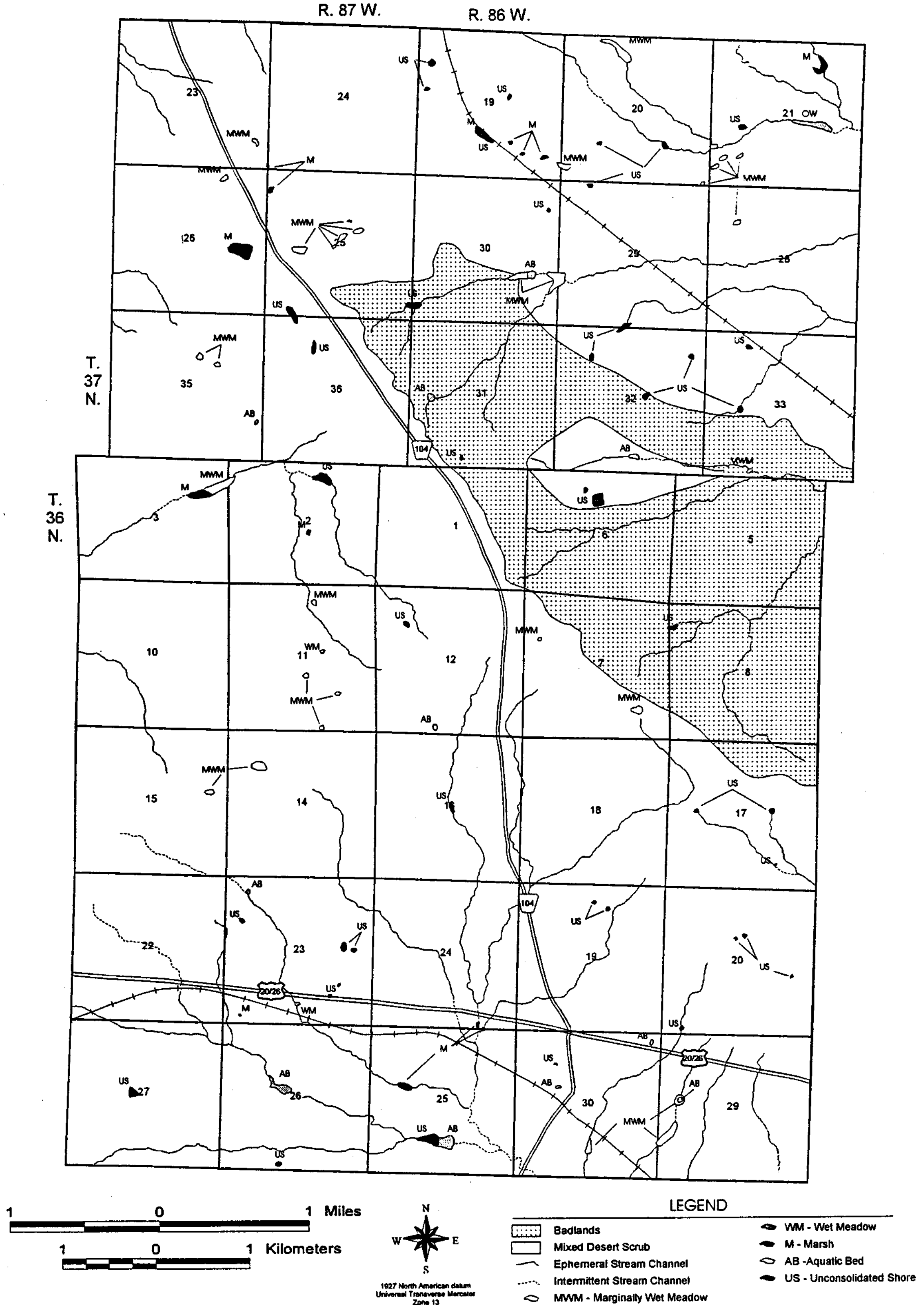


Figure 3-6. Vegetation Cover Types and Aquatic Habitats in the Project Area.

Aquatic Habitats. The aquatic habitat cover type is characterized by low-lying areas where excess moisture accumulates creating unique soil and vegetation conditions as well as important wildlife habitat. These cover types include wet and marginally wet meadows, marsh, unconsolidated bed, vegetated shallows, and stream/drainage channels and/or swales. As discussed in a subsequent section, not all of these habitats are considered jurisdictional wetland subject to the regulations of the federal Clean Water Act (CWA). These cover types have limited distribution within the project area and cover approximately 258 acres (1 percent of the project area). Because many of the aquatic habitats delineated on the National Wetlands Inventory (NWI) maps are long, narrow polygons, the area has been over-estimated. This cover type has very limited occurrence along the Cave Gulch branches, Waltman Draw, Sand Draw, Alkali Creek, and Poison Creek. Table 3-10 classifies aquatic habitats or waters of the U.S. based on the NWI maps and as observed within the project area according to size and the permanence of water.

Areas of wet meadow are supported by temporary saturation at or near the soil surface provided by very limited seeps and springs; limited areas with a shallow water table; and areas where surface runoff collects and frequently ponds for relatively long periods of time. Areas of marginally wet meadow are associated with ephemeral water and generally have a dominance of upland species typical of the mixed desert scrub type. Species in the wet meadow type include inland saltgrass, alkali cordgrass (*Spartina gracilis*), seepweed, rough cocklebur, Baltic rush (*Juncus balticus*), foxtail barley (*Hordeum jubatum*), and thickspike wheatgrass. Greasewood, shrubby cinquefoil (*Potentilla fruticosa*), or silver sagebrush may be present; however, grasses and grass-like plants dominate. Wet meadows have very limited distribution in the project area. Most of these areas are associated with impoundments.

As indicated in Section 3.4, Water Resources, most drainages are ephemeral and carry water on an infrequent basis. Based on field investigations, the drainages indicated in Figure 3-6 lack a well-defined channel and have a dominance of non-hydrophytic vegetation (i.e., western wheatgrass). As such, these channels are more accurately described as vegetated swales.

3.5.2 Waters of the U.S., Including Wetlands

Waters of the U.S. include the territorial seas; interstate waters; navigable waterways such as lakes, rivers, and streams; and special aquatic sites including wetlands; that are, have been, or could be used for travel, commerce, or industrial purposes; tributaries; and impoundments of such waters. All channels that carry surface water flows and that show signs of active water movement are waters of the U.S. Similarly, all open bodies of water and associated wetland vegetation are waters of the U.S. (except ponds and lakes created on upland sites and used exclusively for agricultural activities and aesthetic amenities). Such waters represent unique and important aquatic resources. In addition, the ephemeral drainage channels in the project area that show signs of consistent channel forming processes (i.e., are at bed and grade) and are free of vegetation also qualify as waters of the U.S. However, most drainages in the project area are vegetated swales (i.e., are not covered by a dominance of hydrophytic species) and lack such features. Thus, they are generally not considered waters of the U.S. For the purposes of this EIS, all drainage channels shown on the NWI maps are assumed to be waters of the U.S.

Table 3-10. Classification of Waters of the U.S. within the Project Area.

Cover Type	Cowardin Classification[1]	Area (ac)
Stream Channels		
Ephemeral	Intermittent streambed temporarily flooded (R4SBA)	75
Ephemeral	Palustrine emergent temporarily flooded (PEMA)	21
Intermittent	Palustrine emergent saturated (PEMB)	10
Intermittent	Palustrine emergent seasonally flooded (PEMC)	10
	Total Stream Channel	**116**
Wet Meadow		
Marginally Wet	Palustrine emergent temporarily flooded (PEMA)	43
Wet	Palustrine emergent saturated (PEMB)	25
	Total Wet Meadow	**68**
Marsh	Palustrine emergent seasonally flooded (PEMC)	**19**
Open Water		
Aquatic Bed	Palustrine aquatic bed semipermanently flooded (PABF)	**22**
Unconsolidated Shore	Palustrine unconsolidated shore temporarily flooded (PUSA)	8
	Palustrine unconsolidated shore seasonally flooded (PUSC)	25
	Subtotal Unconsolidated Shore	**33**
	Total Open Water	**55**
	TOTAL AQUATIC HABITATS	**258**

1 - From NWI maps of the project area and Cowardin et al. 1979.

The Corps of Engineers (COE), through Section 404 of the federal Clean Water Act (CWA), regulates activities that involve excavation of or discharge of dredge/fill material into waters of the U.S. To be regulated pursuant to the CWA, an area must meet the definition of a waters of the U.S., special aquatic site, and/or jurisdictional wetland. For a wetland to be jurisdictional, it must show positive evidence of hydrophytic plants, hydric soils, and surface or subsurface water to support such plants and soils under normal circumstances.

Other administrative directives that involve wetlands protection on federally administered land or where federal actions take place include Executive Orders 11990 (wetland protection) and 11988 (floodplain protection).

The NWI maps produced by the U.S. Fish and Wildlife Service (FWS) preliminarily identify aquatic habitats in the project area. According to the NWI maps, wetlands in the project area are associated with drainages and water impoundments. Analysis of the area of aquatic habitats associated with each NWI polygon type are summarized in Table 3-10. As indicated in the Water Resources section, there are approximately 277,465 lineal feet of ephemeral stream channel and 59,870 feet of intermittent stream channel. This equates to an approximate area of 96 acres of ephemeral channel and 20 acres of intermittent channel. Total aquatic habitat associated with stream channels is approximately 116 acres. Total wet meadow is approximately 68 acres comprised of 43 acres of marginally wet meadow and 25 acres of wet meadow. There is approximately 19 acres of marsh in the project area, primarily associated with the margins of stock ponds and other detention structures on streams. Open water habitats are primarily associated with stock ponds and detention structures on drainage channels and include approximately 22 acres of aquatic bed and 33 acres of unconsolidated shore.

Not all of these areas are subject to jurisdiction under the CWA. As such, NWI map delineations do not replace the need for site-specific jurisdictional wetland inventories necessary for CWA 404(b)(1) guidelines compliance conducted during the site-specific and project facility-specific NEPA authorizations made by the BLM. Limited sampling per methods prescribed in the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) was performed to preliminarily identify and locate jurisdictional areas. Accurate identification and location of jurisdictional wetland boundaries was beyond the scope of this EIS but will be accomplished during the permitting and final design stage. Limited field investigations indicate that most wetlands are associated with channel impoundments or depressional areas. Most channels, however, are vegetated swales. Such channels carry water infrequently and lack hydrophytic vegetation; therefore, they are not jurisdictional wetlands or waters of the U.S. Further, impoundments on such swales are also not considered jurisdictional even with a dominance of hydrophytes.

Wetlands have gained considerable recognition for their value in maintaining biological, physical, and socioeconomic systems. Wetland functions, important to humans and environmental quality, include groundwater discharge and recharge, flood storage and desynchronization, shoreline anchoring and dissipation of erosive forces, sediment trapping, nutrient retention and removal, food chain support, wildlife and fish habitat, and heritage values including active and passive recreation and socioeconomic qualities or benefits (aesthetics; education; recreation, consumptive and non-consumptive; non-consumptive-societal; and global processes) (Adamus and Stockwell 1983). Professional judgement was used to determine the functional values of wetlands within the project area following Adamus (1983), Adamus and Stockwell (1983), and Adamus et al. (1987). Values were assigned for each aquatic habitat cover type in Table 3-11. In general, most cover types provide minor functional value, except for wet meadow, marsh, and aquatic bed that provides major functional value in regard to food chain support and wildlife habitat. Values inherently incorporate differences created by the dissimilarity in cover type vegetation height, condition, and hydroperiod.

3.5.3 Weeds and Poisonous Plants

The occurrence of weeds in each cover type varies depending on the extent of surface disturbance. The State of Wyoming has identified 20 designated noxious weeds (Table 3-12); however, not all may occur in Natrona County. In addition to these species, the county includes puncturevine (*Tribulus terrestris*) as a noxious weed (Natrona County Weed & Pest Control District 1996). Not all of these species are present in the project area, but where they are, they occur in the disturbed areas itemized in Table 3-8. Onsite investigation of the project area indicates that quackgrass (*Agropyron repens*), common burdock (*Arctium minus*), Russian knapweed (*Centaurea repens*), Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), houndstongue (*Cynoglossum officinale*), and perennial pepperweed (*Lepidium latifolium*) are the most likely noxious weeds to occur in the project area. Other unwanted weeds observed to occur or that have a high probability of occurrence in the project area include Russian thistle (*Salsola iberica*) and cheatgrass (*Bromus tectorum*) which are the most common weeds in upland areas while rough cocklebur (*Xanthium strumarium*) is common in mesic soils. Canada thistle is also common in the more mesic sites.

Poisonous plants cause injury to animals that ingest them; this injury is due to the presence of a toxic chemical agent. Most of the poisonous plants in the project area are native species. The most common native poisonous plants within the project area include various species of milkvetch (*Astragalus* spp.), horsebrush, greasewood, deathcamas (*Zigadenus* spp.), and arrowgrass (*Triglochin maritimum*). The most common exotic poisonous plants within the project area include halogeton (*Halogeton glomeratus*) and rough cocklebur. In general, these species are common throughout the project area but are minor components of the vegetal cover.

3.5.4 Special Status Plant Species and Communities

Special status plant species include those listed as threatened or endangered under the federal Endangered Species Act of 1973 (ESA), species proposed for federal listing, candidate species under consideration for listing, and other rare or unique species or communities identified by the FWS, BLM, or Wyoming Natural Diversity Database (WYNDD). Several sources of information were researched to determine the special status plants likely to occur in the project area. The *Wyoming Rare Plant Field Guide* (Fertig et al. 1994) provides the most comprehensive information on potential plants in the project area. This source identifies seven special status plants of which only five (many-stemmed spider-flower, Williams' waferparsnip, contracted Indian ricegrass, alpine feverfew, and Devil's Gate twinpod) have a chance of occurring in the project area based on elevation and required habitat. The Casper District BLM no longer recognizes contracted Indian ricegrass as a special status plant based on the large number of occurrences throughout the State and because of its being recommended for down-listing to 3C status.

The FWS was contacted to determine if additional species occur in the project area, and none were identified (USDI-FWS 1996). Inquiries to the WYNDD (1995 and 1996) and the USDI-FWS revealed no known threatened or endangered plant species or species proposed for listing within the project area. The results of the WYNDD database search included a township buffer around the project area because Wyoming is poorly known floristically and such a buffer may include species that have a reasonable chance of occurring in the project area.

The 1995 database inquiry revealed records for three sensitive species: bun milkvetch, Williams' waferparsnip, and contracted Indian ricegrass. The 1996 inquiry revealed three species as well: smooth goosefoot, Williams' waferparsnip, and Devil's Gate twinpod; smooth goosefoot being added. Although none of the element occurrences were within the project area, they did occur in nearby areas. Based on these sources of information, and eliminating contracted ricegrass for the reasons previously identified, there are six plant species that have a chance of occurring in the project area. These species are summarized in Table 3-13.

Habitat for bun milkvetch does not occur within or near the project area. Further, there are no known records of this species occurring in or near the project area and therefore, is unlikely to occur. There are records of smooth goosefoot occurring near the project area. Further, its preferred habitat occurs in the project area and therefore, it is possible this species may occur in the project area. There are no records of many-stemmed spider-flower occurring in or near the project area; however, suitable habitat is present and therefore, it is possible that this species may occur in the project area. Williams' waferparsnip occurs to the north of the area and at higher elevations. It has not been observed in the area (Soehn 1995) and therefore, it is unlikely to occur in the project area. There are no records of alpine feverfew occurring in or near the project area and suitable habitat is not present and therefore, it is unlikely that this species occurs in the project area. There are records of Devil's Gate twinpod occurring near the project area. Further, its preferred habitat may occur in the project area and therefore, it is possible this species may occur in the project area. Table 3-13 summarizes the legal/management status, habitat, and probability of occurrence for the six species.

Table 3-11. Estimated Functional Values Waters of the U.S. within the Project Area.

AQUATIC HABITAT COVER TYPE	WETLAND FUNCTION[1,2]								
	GWR	GWD	FSD	SAD	SED	NRR	FCS	HAB	REC/ HER
Stream Channel	x	x	o	o	o	o	x	x	o
Wet Meadow	x	x	x	x	x	x	+	+	x
Marsh	x	x	x	+	+	+	+	+	x
Aquatic Bed	x	x	x	o	+	x	+	+	x
Unconsolidated Shore	o	x	x	o	+	o	x	x	x

1 - **Values:**
+ - major functional value
x - minor functional value
o - no or negligible functional value

2 - **Wetland and Special Aquatic Habitat Functions (Adamus and Stockwell 1983):**

GWR - groundwater recharg
GWD - groundwater discharge
FSD - flood storage and desynchronization
SAD - shoreline anchoring and dissipation of erosive forces
SED - sediment trapping
NRR - nutrient retention and removal
FCS - food chain support
HAB - wildlife and fish habitat
REC - active and passive recreation and heritage value

Table 3-12. Designated Noxious Weeds for the Project Area.

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Agropyron repens	Quackgrass	*Cynoglossum officinale*	Houndstongue
Arctium minus	Common burdock	*Euphorbia esula*	Leafy spurge
Cardaria draba, C. pubescens	Hoary cress, whitetop	*Fraseria discolor*	Skeletonleaf bursage
Carduus acanthoides	Plumeless thistle	*Isatis tinctoria*	Dyers woad
Carduus nutans	Musk thistle	*Lepidium latifolium*	Perennial pepperweed
Centaurea diffusa	Diffuse knapweed	*Linaria dalmatica*	Dalmatian toadflax
Centaurea maculosa	Spotted knapweed	*Linaria vulgaris*	Yellow toadflax
Centaurea repens	Russian knapweed	*Onopordum acanthium*	Scotch thistle
Chrysanthemum leucanthemum	Ox-eye daisy	*Sonchus arvensis*	Perennial sowthistle
Cirsium arvense	Canada thistle	*Tribulus terrestris*	Puncturevine
Convolvulus arvensis	Field bindweed		

1 - Source: Natrona County Weed & Pest Control District (1995).

Table 3-13. Special Status Plant Species, Status, and Habitat Characteristics.[1]

SCIENTIFIC NAME	COMMON NAME	STATUS[2]	HABITAT	PROBABILITY OF OCCURRENCE[3]
Astragalus simplicifolius	Bun milkvetch	G3, S3, WYNDD E, Casper-BLM PRRA	Habitat: reddish sandstone soil. Elevation: 6,500 ft. Associated vegetation: *Erigeron* and *Lithospermum* Flowering/fruiting: unknown	unlikely
Chenopodium subglabrum	Smooth goosefoot	G3, S2, WYNDD P, Casper-BLM PRRA	Habitat: sand dune and sandy slopes; limited distribution. Elevation: 5,900 ft. Associated vegetation: unknown. Flowering/fruiting: unknown.	possible
Cleome multicaulis	Many-stemmed spider-flower	G2/S1, C2, Casper-BLM PRRA	Habitat: semi-moist, open, saline banks of shallow ponds and lakes. Elevation: 5,900 ft. Associated vegetation: Baltic rush and bulrush. Flowering/fruiting: June-August.	possible
Cymopterus williamsii	Williams waferparsnip	3C, G3, S3, Casper-BLM PRRA, WYNDD E	Habitat: open, exposed limestone outcrops or rock slides on summit and upper slopes of large ridge; in cracks and in tilted bedrock on lower slopes. Elevation: 6,000-8,300 ft. Associated vegetation: unknown. Flowering/fruiting: May-June/June-July.	unlikely
Parthenium alpinum	Alpine feverfew	CG2G3/S2S3, Casper-BLM PRRA	Habitat: cushion plant community on open slopes and ridges, often on calcareous substrates. Elevation: 4,400-6,400 ft. Associated vegetation: cushion plant community species. Flowering/fruiting: May-June.	unlikely
Physaria eburniflora	Devil's Gate twinpod	C2, G2, S2, WYNDD E, Casper-BLM PRRA	Habitat: rocky juniper slopes; cushion plant communities on calcareous ridges, crumbly sandstone/limestone, or soil crevices in granite outcrops. Elevation: 6,100-9,700 ft. Associated vegetation: unknown. Flowering/fruiting: May-June/June-July.	possible

1 - Sources: Atwood et al. (1994), Fertig et al. (1994), Soehn (1995), USDI-FWS (1995 and 1996), WYNDD (1995 and 1996).

2 - Definition of status

U.S. Fish and Wildlife Service (Federal) Rank

E	Listed Endangered. Taxa formally listed as Endangered. Species, subspecies, or populations that are threatened with extirpation or extinction resulting from very low or declining numbers, alteration and/or reduction of habitat, detrimental environmental changes, or any combination of the above. Continued long-term survival is unlikely without implementation of special measures.
T	Listed Threatened. Taxa formally listed as Threatened. Species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
P	Proposed for Listing. Taxa formally proposed for listing as Threatened or Endangered in the Federal Register.
C1	Category 1 Candidate. Taxa for which substantial information exists on file on the biological vulnerability and threats to support proposing to list taxa as Endangered or Threatened.
C2	Category 2 Candidate. Taxa for which current information indicates that proposing to list as Endangered or Threatened is possible, but appropriate or substantial biological information is not on file to support an immediate ruling (i.e., there is some evidence of vulnerability but additional study is needed).
3C	Category 3C Candidate. Taxa that have been proven to be more abundant or widespread than had been previously believed, and/or those that are not subject to any identifiable threat.

Heritage Ranks/Definitions

G	Global rank; based on the range-wide status of a species
T	Trinomial rank; based on the range-wide status of a subspecific taxon (i.e., a subspecies or variety)
S	State rank; based on the status of a species in Wyoming (state ranks may differ in other states)
1	Critically imperilled because of extreme rarity (5 or fewer occurrences or very few remaining individuals) or because of some factor of a species' life history that makes it especially vulnerable to extinction.
2	Imperiled because of rarity (6 to 20 occurrences) or because of other factors demonstrably making a species vulnerable to extinction.
3	Rare or local throughout its range or found locally in a restricted range (21 to 100 occurrences).
4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.
5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

WYNDD Rank

E	Endemic to Wyoming; species that occur only within the borders of the state.
R	Regional Endemic; species with a global range restricted to Wyoming and one to two adjacent states. The entire range of the species is less than the total area of the state of Wyoming.
D	Disjunct; Wyoming occurrences of a species are widely separated from the main contiguous portion of its range.
P	Peripheral; Wyoming occurrences of a species are at the edge of its continuous range.

Other Codes

?	Assigned status questionable.
RWL	Recommended for the Watch List for a given resource area of the BLM (PRRA = Platte River Resource Area).

3 - Probability based on presence of habitat and known distribution.

3.6 RANGE RESOURCES AND OTHER LAND USES

3.6.1 Range Resources

Grazing of livestock is the predominant agricultural activity within the Cave Gulch-Bullfrog-Waltman project area. Seven BLM grazing allotments lie within or partially within the project area. These allotments are summarized in Table 3-14. Of the seven, only one allotment, the Sand Draw allotment, is located entirely within the project area. Approximately 6,829 federal acres in the project area are leased as public grazing allotments. The South Cave Gulch allotment contains the largest portion of public land in the project area, with 4,050 acres (16.14 percent of the project area) leased for grazing. Keg Spring Draw allotment contains only 74 acres (0.29 percent of the project area) of public land.

The livestock carrying capacity on public lands within the Cave Gulch-Bullfrog-Waltman project area varies from eight acres per animal unit month (AUM) to 21 acres per AUM. The approximate average on public lands throughout the project area is 11 acres per AUM. However, livestock carrying capacity in the project area on deeded and public lands combined is approximately 8-9 acres per AUM (M. Phillips pers. comm.).

These allotments are managed for cattle on a year-round or rotational grazing system involving BLM land, private lands and some State of Wyoming lands. Low levels of horse use occur on most of the allotments. A total of 656 AUMs are currently leased on public lands within the project area.

Seven range improvements exist within the Cave Gulch-Bullfrog-Waltman project area. Review of the BLM's recorded Range Improvement Projects (RIP) show three reservoirs (Mario Reservoir, Break Reservoir, and Enoch 2 Reservoir) and four fences (the Rochelle Fence, Walton Fence, Irvine Brothers Fence, and Doubles Fence).

3.6.2 Other Land Uses

The 25,093 acre Cave Gulch-Bullfrog-Waltman project area contains approximately 7,391 federally owned acres; 16,467 privately owned acres; and 1,235 acres that are State of Wyoming lands. The BLM administers federal lands and the State of Wyoming manages the State School Trust Lands. The entire project area is within the BLM Platte River Resource Area.

Major land uses within and adjacent to the Cave Gulch-Bullfrog-Waltman project area are agriculture (primarily cattle and sheep grazing); wildlife habitat; oil and natural gas exploration, development, and transportation; and dispersed outdoor recreation (primarily hunting in the fall). No developed recreation facilities exist within or adjacent to the project area.

Review of the Platte River Resource Area ROW records shows the project area as having a considerable amount of surface activity, most of which is gas and oil related. Of the 26 existing right-of-ways currently on record relating to surface disturbing actions, 16 (62 percent) are natural gas pipelines and 4 (15 percent) are road ROWs. Other ROWs include 3 (12 percent) for power facilities and 3 (12 percent) for telephone and telegraph facilities.

Table 3-14. Approximate Acreage and Number of Public AUMs on Grazing Allotments within the Cave Gulch-Bullfrog-Waltman Project Area.

Allotment Number	Lessee(s)	Total Public Acres	Public Acres in Project Area	Percent of Project Area	Total Public AUM's	Public AUM's in Project Area	Acres per AUM
South Cave Gulch (10006)	Flying A Ranch c/o Bob Britain	5,130	4,050	16.13	395.00	314.00	13
Powder River Draw (10007)	Norman Preator	2,080	480	1.91	229.50	57.70	9
Sand Draw (20512)	Norman Preator	160	160	0.64	18.00	18.00	9
Waltman[a] (10008)	Carlson Ranch	1,280	880	3.51	139.49	103.28	9
	C.A. Fenton	440	200	0.80	49.00	22.00	9
	Flying A Ranch	140	0	0.00	16.00	16.00	9
Keg Spring Draw (10029)	Deer Creek Ranch	579	74	0.29	45.31	3.50	21
South Hiland (10030)	Deer Creek Ranch	6127	200	0.80	871.83	23.89	9
Miller (10130)	Daniel Miller	1,185	785	3.13	138.00	98.00	8
Total		17,121	6,829	27.21	1,902.13	656.37	

[a] The Waltman Allotment is an "in common" allotment, where each lessee can take their allocated AUM's throughout the allotment, not just on the legal locations assigned to them in the BLM grazing lease.

[b] Source of table: Bureau of Land Management, Casper District, Grazing Lease Data Worksheets.

3.7 WILDLIFE

3.7.1 Wildlife Habitats

Wildlife habitats that would be affected by the project include both the areas which would be physically disturbed by the construction of production wells, related roads, pipelines, and production facilities, as well as the zones of influence surrounding them. Zones of influence are defined as those areas surrounding, or associated with, project activities where impacts to a given species could occur. The shape, and extent of such zones, varies considerably with species and circumstance.

Four primary wildlife habitats are associated with the proposed project. These habitat types correspond with vegetation cover types described in detail in the Vegetation section (Sect. 3.5) of this document and include two upland and two general aquatic types. Upland habitats include: (1) mixed desert shrub and (2) badlands. General wetland habitats include: (1) wet meadow/marsh, and (2) aquatic bed.

3.7.2 General Wildlife

Approximately 49 wildlife species have been recorded on or proximal to the project area either as residents or as migrants. These include 19 species of mammals and 30 species of birds. A list of the species observed in the project area and surrounding region is presented in Appendix F. The presence and distribution of these wildlife species were determined from published literature, unpublished data from federal and state agencies, databases from private organizations, and on-site surveys conducted during 1994, 1995, and 1996 (HWA 1995 and 1996). It should be noted that this does not represent a comprehensive list, since, except for raptors and prey species (i.e. large rodents and lagomorphs), no other wildlife surveys have been conducted.

Although all of the species in Appendix F are important members of wildland ecosystems and communities, most are common and have wide distributions in the region. Consequently, the discussion is focused on species which are threatened, endangered, rare, game species, or are otherwise of high interest or unique value.

3.7.2.1 Big Game

Pronghorn antelope (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only big game species found in the project area. These animals are managed by the Wyoming Game and Fish Department (WGFD) within major herd units and are discussed in that context.

Pronghorn Antelope. Although pronghorn are not abundant on the study area, they are the most common big game animal in the project area. The project area encompasses portions of four major antelope herd units: North Natrona, Rattlesnake, Beaver Rim, and Badwater (Figure 3-7). Approximately 1.47, 0.14, 0.09, and 1.36 percent of the respective herd units are contained within the project area. Major differences exist between the herd units with regard to habitat, antelope population characteristics, and harvest strategies. The boundaries for these units generally correspond with major roads, which when fenced, prevent antelope from migrating across unit boundaries, which results in relatively little interchange between them. Data on major antelope herd units are summarized in Table 3-15.

As shown in Figure 3-7, the North Natrona herd unit is located almost immediately north and west of Casper and extends to Waltman, Edgerton, and the southern end of the Bighorn Mountains. Antelope hunt area 73 includes the entire herd unit which encompasses 1,350 sq. miles. Approximately 47 percent of the herd unit is on state and federal lands and the remainder is on land held in private ownership (WGFD 1996a).

Beginning in 1987, harvest levels in this herd were reduced to allow it to increase to a new population objective of 7,500 animals. From 1986 through 1992 the population increased to more than 14,000 antelope, but has decreased since that time. The North Natrona antelope herd unit had a 1995 post-season population of 6,067 animals which is 33 percent below objective. Pre-hunt production ratios in 1995 were 72 fawns per 100 does which was down from 80:100 in 1994 and slightly below the five year average of 76 fawns per 100 does (WGFD 1996a).

The portion of the project area within the North Natrona herd unit lies entirely within yearlong range for pronghorn antelope and encompasses approximately 12,684 acres (Figure 3-7). There is no crucial winter range for antelope within the project area and the only areas identified as crucial winter range occur in the southern portion of the herd unit between Powder River and Bucknum. The best habitat for pronghorn in the herd unit is in the sandy dunes north of Goldeneye and Natrona and the rolling sagebrush plains running through the middle of the herd unit (WGFD 1996a).

The Rattlesnake herd unit encompasses only 931 acres within the southeast portion of the project area and is bounded on the north by U.S. Highway 20-26 to Waltman, Wyoming Highway 220 eastward to Alcova, and north to Casper along the North Platte River (Figure 3-7). The herd unit encompasses 1,025 sq. miles which includes hunt areas 70, 71, and 72. Nearly half (47%) of the herd unit is on public lands which occur in larger accessible blocks in the western portion (WGFD 1996b).

The Rattlesnake herd unit had a 1995 post-season population of 5,024 animals which is 58 percent below objective and 14 percent below the 1994 estimate. The five year population average (1990-94) was 9,565 animals, or 20 percent below objective. Pre-hunt production ratios in 1995 were 68 fawns/100 does which was slightly below the previous five year average of 71 fawns/ 100 does (WGFD 1996a).

The portion of the project area within the Rattlesnake herd unit lies entirely within winter/ yearlong range for pronghorn antelope and no crucial winter range is present (Figure 3-7). The nearest crucial winter range occurs approximately 10 miles to the southwest near Powder River. Major habitats used by antelope within this herd unit include big sagebrush/ grassland, black greasewood, and Nuttall saltbush types.

The Beaver Rim herd unit lies south of U.S. Highway 20-26 to Waltman, Wyoming 220 eastward to Alcova, westward to Atlantic City, and north to Riverton along the Continental Divide. The herd unit encompasses 4,504 sq. miles which includes hunt areas 65, 66, 67, 68, 69, 74, and 106.

Nearly 80 percent of the herd unit is on public lands and the remainder is held in private ownership (WGFD 1996c).

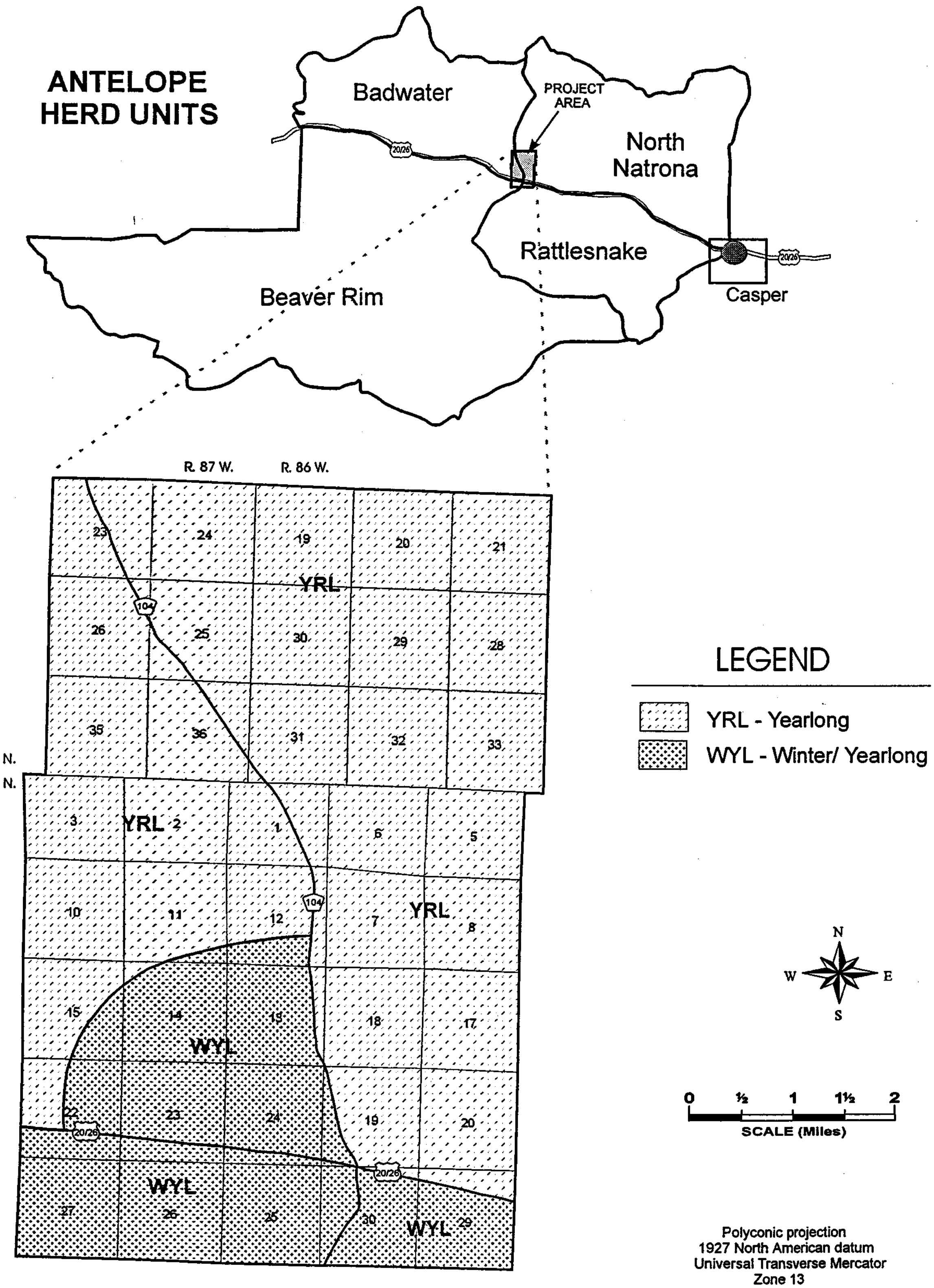


Figure 3-7. Pronghorn Antelope Herd Units and Seasonal Ranges Shown in Relation to the Cave Gulch-Bullfrog-Waltman Project Area.

Table 3-15. Population Parameters for Big Game Herd Units within the Cave Gulch-Bullfrog-Waltman Project Area.

Species	Herd Unit	Herd Unit Number	Hunt Areas	Size (Sq. miles)	Population Estimate[1]	Population Objective[1]	Density Estimate[2]	% Contained within Project Area	Fawn:Doe Ratio[1]
Antelope	North Natrona	746	73	1,350	6,067	9,000	4.5	1.47	72:100[a]
	Rattlesnake	745	70-72	1,025	5,024	12,000	4.9	0.14	68:100[a]
	Beaver Rim	632	65-69, 74, 106	4,504	15,383	25,000	3.4	0.09	44:100[a]
	Badwater	634	75	1,032	2,596	3,000	2.5	1.36	64:100[a]
Mule Deer	North Natrona	759	34	1,326	2,581	6,500	1.9	1.49	70:100[b]
	Rattlesnake	758	88, 89	1,232	2,569	5,500	2.1	0.12	55:100[b]
	Southwest Bighorns	208	35-40, 42, 43, 164	3,378	21,754	28,000	6.4	0.41	51:100[b]
	Beaver Rim	648	90	1,414	936	2,600	0.7	0.28	62:100[b]

[1] Data for 1995
[2] No. individuals per sq. mile of habitat
[a] Pre-season estimates
[b] Post-season estimates

The Beaver Rim antelope herd unit numbers were significantly below the objective of 25,000 antelope in 1995. This has been attributed to the long-term impact of sustained drought over the last decade which has reduced fawn survival and yearling recruitment. In addition, an increase in winter mortality during the winter of 1992-1993, followed by a liberal hunting season in 1993, have contributed further to this decline (WGFD 1996c). In 1995, fawn production remained poor at 44 fawns/100 does. If the fawn/doe ratio remains below 50:100 it is unlikely that the objective for this herd will be reached in the foreseeable future, even with the implementation of very conservative harvest strategies (WGFD 1996c).

The portion of the project area within the Beaver Rim herd unit lies entirely within yearlong range for pronghorn antelope and encompasses approximately 2,507 acres. No crucial winter range is present within the project area. The nearest crucial winter range occurs approximately.

The Badwater herd unit lies north of U.S. Highway 20-26 and extends from Waltman west to Shoshoni, and northward to the southern end of the Bighorn Mountains (Figure 3-7). Antelope hunt area 75 includes the entire herd unit which encompasses 1,032 sq. miles. Approximately 60 percent of the herd unit is on state and federal lands and the remainder is held in private ownership (WGFD 1996b).

The Badwater antelope herd unit had a 1995 post-season population that was estimated to be 13 percent below the objective of 3,000 animals. An increase in this objective has recently been discussed, however, WGFD field biologists recommended that the objective remain at the current level due to the poor condition of browse resources (WGFD 1996c). Data from the WGFD (1996c) indicate an overall low fawn production and reduced yearling recruitment from 1992 through 1994 and suggest that poor browse conditions resulting from sustained drought during the last decade, have negatively affected this population. The observed 1995 pre-season doe/fawn ratio was 64 fawns/100 does and represents a slight increase over that observed during the previous two years. This increase was attributed to an increase in forage production during the summer of 1995 as a result of the unusually high levels of precipitation during the preceding spring (WGFD 1996c).

The western portion of the project area, located within the Badwater herd unit, contains approximately 6,009 acres of yearlong and 2,962 acres of winter/yearlong range for pronghorn antelope (Figure 3-7). No crucial winter range is present within the project area. The nearest crucial winter range occurs approximately 3 miles west of the project area near Hiland and about 1 mile northwest near Arminto. During 1994, pronghorn antelope in this herd unit were concentrated along the east shore of Boysen Reservoir, Badwater Creek, Bridger Creek and higher elevation portions of the south Bighorn Mountains and Copper Mountain.

Seasonal distribution of pronghorn is influenced primarily by the availability of water within the herd units. There are few sources of natural water within the units, and where irrigated hay fields exist, antelope tend to congregate and cause crop damage (WGFD 1996a).

<u>Mule Deer.</u> The project area lies within four mule deer herd units: North Natrona, Rattlesnake, Southwest Bighorns, and Beaver Rim (Figure 3-8). The portions of the project area located within the Southwest Bighorns and Beaver Rim mule deer herd units are designated as unsuitable habitat for mule deer. The nearest crucial winter ranges within the Southwest Bighorns and Beaver Rim herd units are located approximately 10 miles north and 15 miles southwest, respectively, of the project area. Data on major mule deer herd units are summarized in Table 3-15.

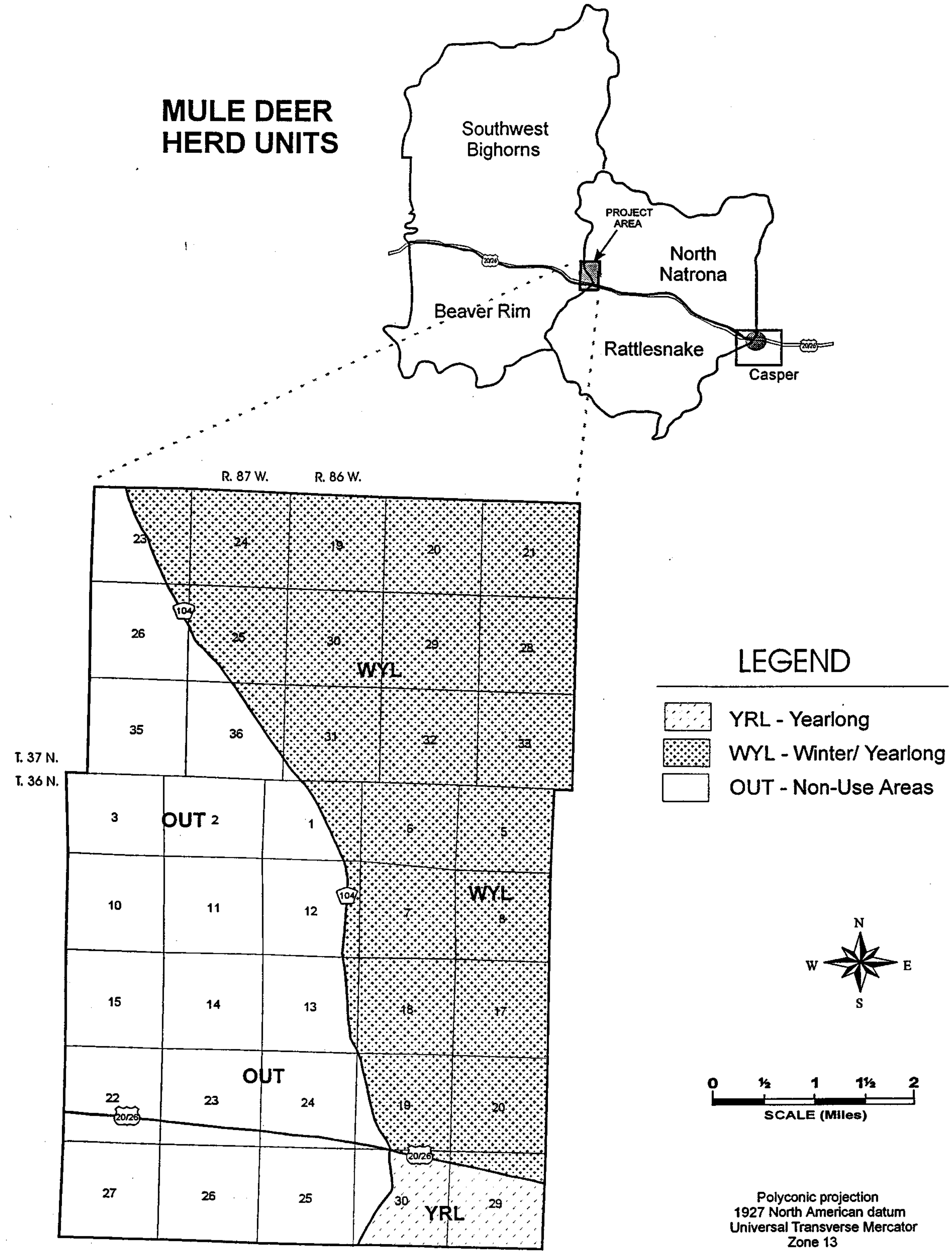


Figure 3-8. Mule Deer Herd Units and Seasonal Ranges Shown in Relation to the Cave Gulch-Bullfrog-Waltman Project Area.

The unit boundaries of the North Natrona mule deer herd correspond closely with the boundaries of the North Natrona antelope herd unit. This unit is located immediately north and west of Casper and includes the southern end of the Bighorn Mountains (Figure 3-8). Deer hunt area 34 includes the entire herd unit which encompasses 1,326 sq. miles. Approximately 49 percent of the herd unit is on public lands (WGFD 1996b).

The North Natrona mule deer herd unit had a 1995 post-season population of 2,581 animals which is 60 percent below objective. Despite the fact that production during 1995 increased to a five year high with a ratio of 70 fawns per 100 does, this herd historically has had a low doe:fawn ratio and therefore a slow growth rate (WGFD 1996a). Harvests for this herd unit have been managed under a limited quota strategy since 1985. The relatively slow growth potential and localized concentrations of deer in this herd make them somewhat vulnerable to over-harvest (WGFD 1996a).

Saltbush steppe vegetation covers large portions of the central part of this herd unit. Most of the area within the herd unit is comprised of yearlong range for mule deer and is of marginal quality (WGFD 1996a). The portion of the project area within the North Natrona herd unit is comprised exclusively of winter/yearlong range for mule deer (Figure 3-8). The only areas identified as crucial winter range within the North Natrona herd unit occur in the northwest part of the unit near Buffalo Creek, approximately 5.5 miles from the project area.

The Rattlesnake mule deer herd unit, located west of Casper, occupies 1,232 sq. miles and includes hunt areas 88 and 89 (Figure 3-8). State and federal lands comprise about 58 percent of this herd unit, which occurs in larger, accessible blocks in the western and southern portions (WGFD 1996b).

The 1995 post-season population estimate for the Rattlesnake herd unit was 2,569 animals which is about 53 percent below the objective of 5,500 mule deer and 28 percent below the five year average of 3,591 deer. Production increased from 44 fawns/ 100 does in 1994 to 55:100 in 1995, which is comparable to the five year average of 54:100 (WGFD 1996c).

The portion of the project area within the Rattlesnake mule deer herd unit encompasses only 931 acres and lies entirely within yearlong range for mule deer (Figure 3-8). No crucial winter range is present in the project area and the nearest crucial winter range occurs approximately 8 miles to the southwest. The Southwest Bighorns and Beaver Rim mule deer herd units have not been discussed in detail because the portions of the project area that lie therein are not classified as mule deer habitat.

3.7.2.2 Upland Game Birds

The mourning dove (*Zeniada macroura*) and sage grouse (*Centrocercus urophasianus*) are the only upland game bird species known to occur on the project area.

Mourning Dove. Mourning doves are found on the project area during the summer months and are associated with mainly sagebrush-grass, mountain brush, and riparian habitats. Brood production is tied closely to spring and summer precipitation because increased productivity in mourning doves depends on the availability of sufficient seed and water supplies.

Sage Grouse. The sage grouse is the predominant and most important game bird in the project area. The WGFD manages sage grouse by upland game management areas. The project area is contained within three upland game management units which include the North Natrona (Area 32), Rattlesnake (Area 33), and Muskrat (Area 18) units (Figure 3-9).

Data from the WGFD indicate that harvest numbers of sage grouse have declined between 1991 and 1995 with a current annual harvest of only 199, 227, and 75 birds for Areas 32, 33, and 18, respectively (Table 3-16). This trend is also apparent in state-wide numbers of sage grouse which declined sharply between 1991 and 1995 (Table 3-16). Low availability of grouse probably resulted from poor production and low chick survival due to the continued drought conditions throughout the region (WGFD 1996d).

Although only marginal sage grouse habitat occurs on the central and southern portions of the project area, better habitats occur in the northern reaches where several observations of sage grouse/sagegrouse sign were made during field work conducted during 1995 and 1996. Although no leks are known to occur within three miles of the project area, sage grouse are known to utilize the area as seven documented sightings of sage grouse or grouse droppings have been recorded since the early 1980s. Important areas for these birds consist of strutting grounds, brood-rearing areas, and wintering areas. Leks may be located between summer and winter ranges, or in some cases summer and winter ranges may be the same (Call and Maser 1985). Preferred nesting habitat is usually within a two-mile radius of the strutting grounds (Call 1974, Braun et al. 1977, Hayden-Wing et al. 1986).

Based on data from the Wildlife Observation System (WOS), a total of 19 historical lek locations were identified within a two township-wide buffer around the project area (WGFD 1996e)(Table 3-17). Only 5 of these leks were documented as active within the last five years and of these, only 2 were reported to be active as recently as two years ago.

3.7.2.3 Raptors

A raptor monitoring and nest inventory process was initiated in 1994 for the project area. The initial study area consisted of approximately 10 sq. miles. However, in early 1995 there was a dramatic escalation in natural gas development in the Cave Gulch area as more operators announced their intention to develop new leases within the region. As a result of increased concern over the impact of this development on raptor populations in the region, the BLM recommended an increase in the size and extent of the raptor monitoring and inventory area. In 1996, this area was expanded to include 273 sq. miles (Figure 3-10). This expanded raptor analysis area is comprised of several gas/oil fields in varying stages of development and includes the relatively undisturbed habitats between them. According to recommendations made by Bob Oakleaf of the Wyoming Game and Fish Department (WGFD), raptor monitoring on the expanded area will allow for a more flexible management approach by obtaining a more complete picture of raptor distribution, habitat use, and factors affecting reproductive success in areas of gas/oil field development and similar but less developed habitats.

Table 3-16. Sage Grouse Harvest Results by Management Area from 1990-1995 (WGFD 1995c).

Upland Game Management Unit	YEAR 1990	1991	1992	1993	1994	1995
North Natrona - 32	307	610	126	193	116	199
Rattlesnake - 33	768	1,344	558	606	266	227
Muskrat - 18	665	860	725	586	364	75
SUBTOTAL	1,740	2,814	1,409	1,385	746	501
STATEWIDE TOTAL	41,786	47,918	34,388	30,469	26,458	13,975

Table 3-17. Sage Grouse Lek Locations on and within a Two Township Buffer of the Cave Gulch-Bullfrog-Waltman Project Area.

Date of Last Activity	No. Males	No. Females	No. Unknown	Twn N	Rng W	Sect.	¼ Sect.
04-03-91	54	0	0	37	86	12	SE
04-03-91	0	1	0	38	85	9	SW
04-09-82	0	0	1	35	85	6	-
04-10-91	0	1	1	35	85	29	NW
04-10-96	7	4	0	38	87	23	-
04-16-79	1	0	0	36	86	1	SW
04-16-88	27	7	0	38	87	23	SW
04-19-90	24	5	0	37	86	12	NE
04-20-94	14	7	0	38	87	23	-
04-21-82	17	0	0	35	86	16	NW
04-23-96	0	0	7	38	87	26	NW
04-25-87	19	2	0	36	85	6	SW
04-25-87	13	9	0	38	87	23	SW
04-25-89	18	0	0	38	87	23	SW
04-27-87	33	0	0	35	85	33	NW
04-28-87	8	0	0	35	86	26	SW
04-28-87	10	0	0	35	86	35	NW
05-01-90	35	2	0	36	85	6	SW
05-19-86	25	6	0	38	87	24	NW

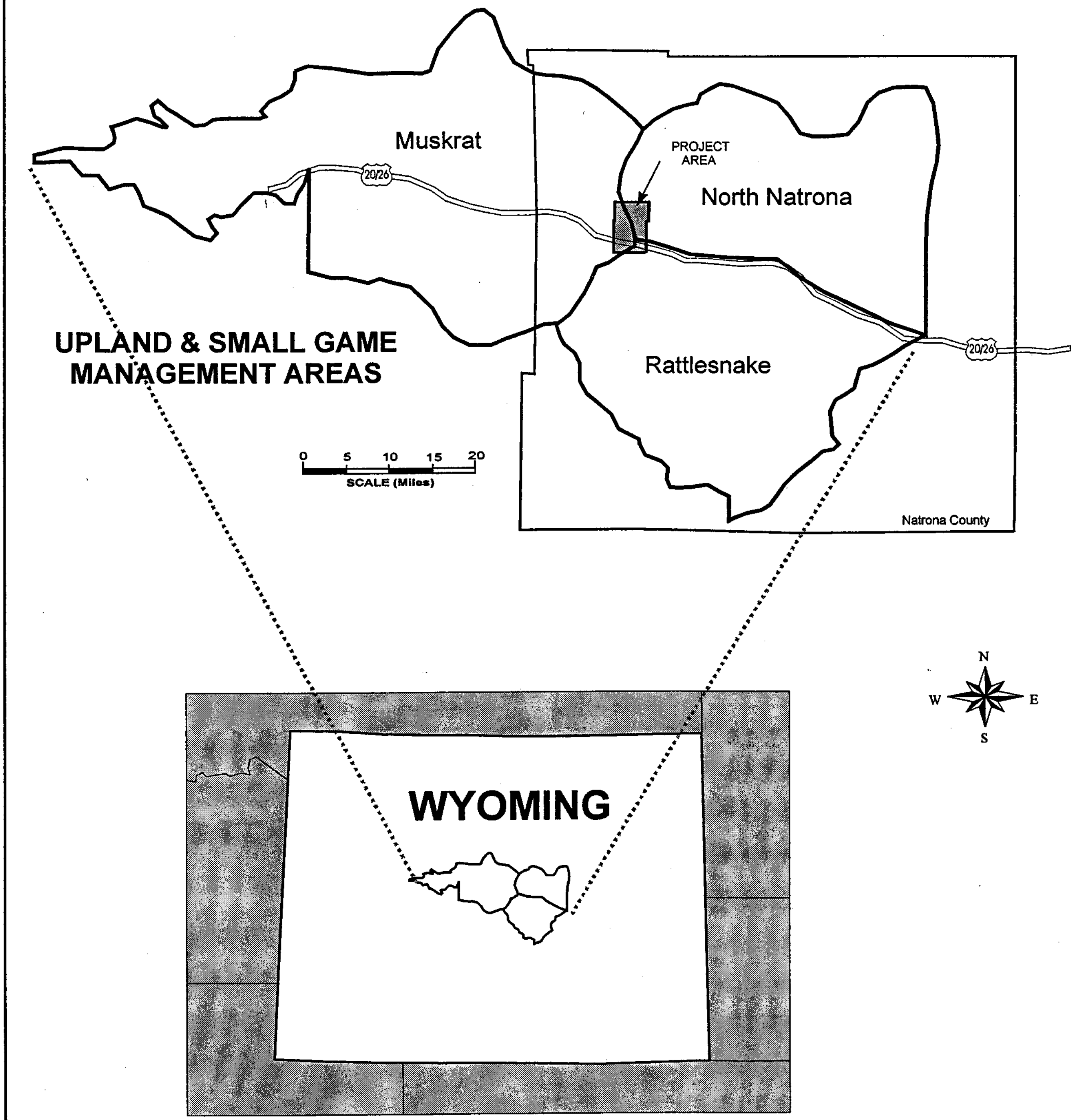


Figure 3-9. Upland & Small Game Management Areas Shown in Relation to the Cave Gulch-Bullfrog-Waltman Project Area.

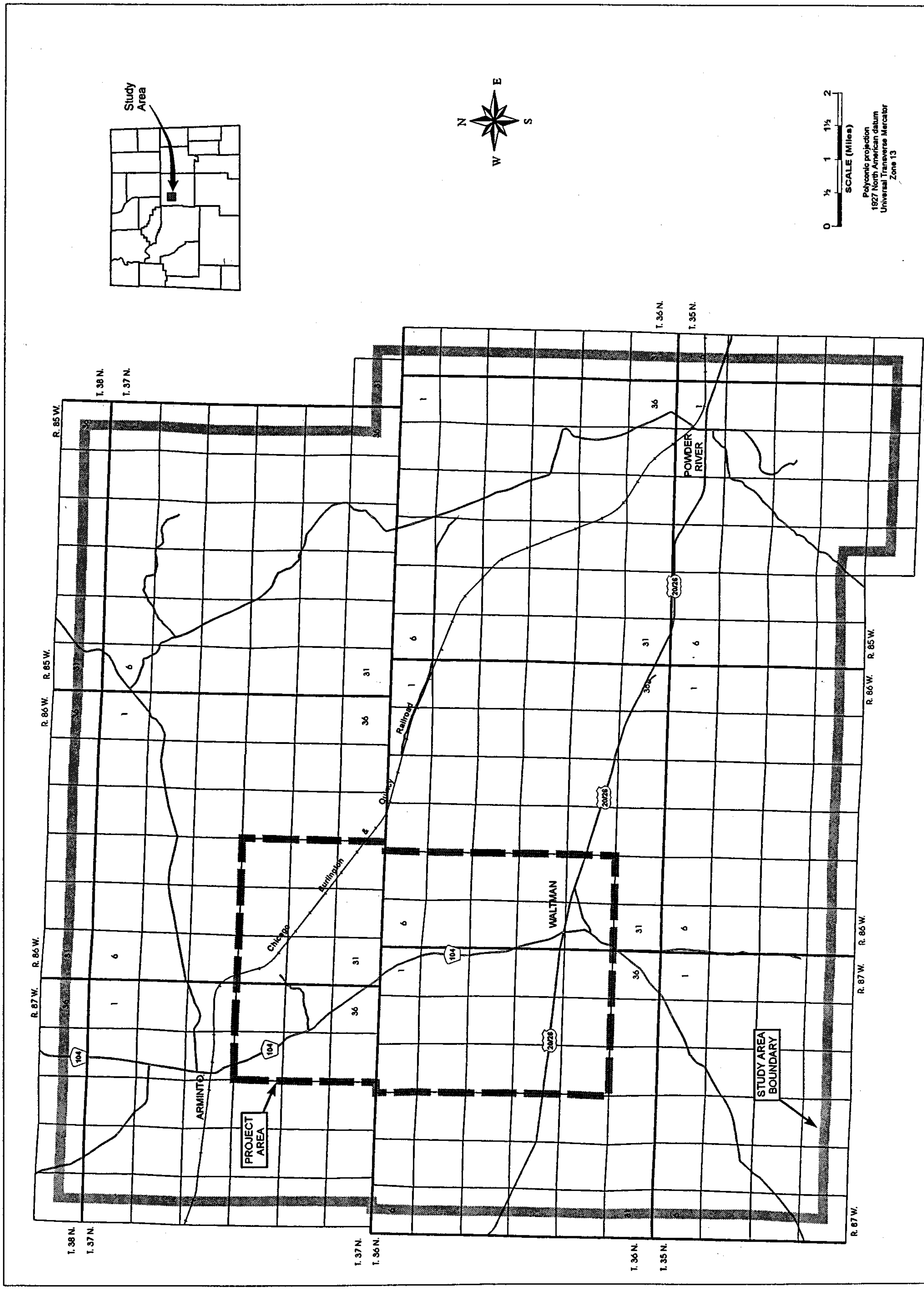


Figure 3-10. The 273 Sq. Mile Greater Raptor Analysis Area Shown in Relation to the Cave Gulch-Bullfrog-Waltman Project Area.

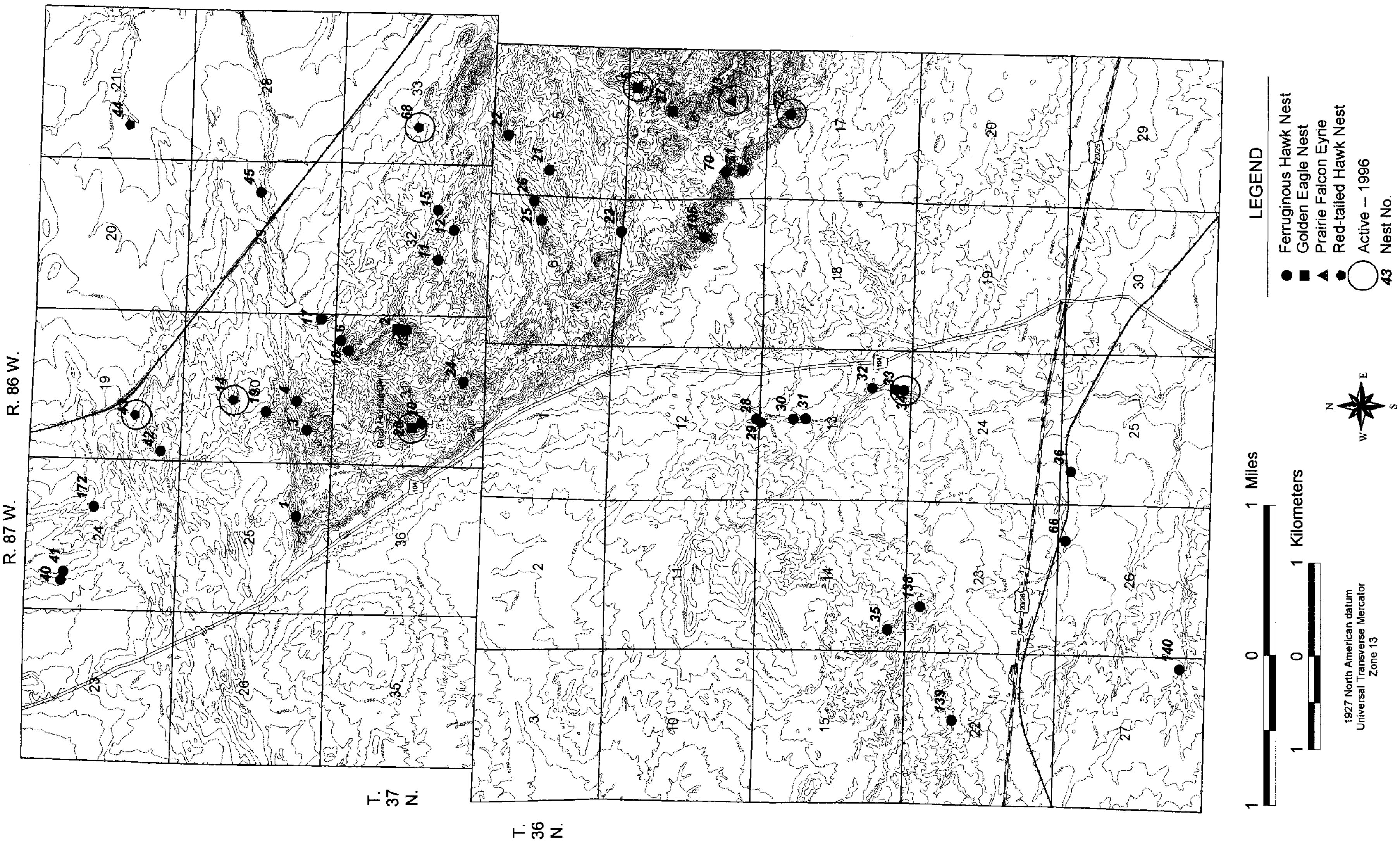


Figure 3-11. Raptor Nest Locations and Status on the Cave Gulch-Bullfrog-Waltman Project Area.

Results of past raptor inventories within the region, beginning in 1994, suggest that the status of raptor nests varies from year to year depending on prey base availability and other factors (HWA 1995 & 1996). A comprehensive examination of the dynamics and past history of raptor nest site locations and status within the Cave Gulch Area is presented in the Raptor Technical Report for the Cave Gulch Area (HWA 1995 and 1996).

As indicated in the computerized records of the WOS of the WGFD and field observations made by HWA and BLM biologists, raptor species known to occur in the region include: the red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), rough-legged hawk (*Buteo lagopus*), golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), American kestrel (*Falco spavarius*), great-horned owl (*Bubo virginianus*), burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), and Northern harrier (*Circus cyaneus*). Five raptor species are currently known to nest in the project area: the golden eagle, ferruginous hawk, red-tailed hawk, prairie falcon, and great-horned owl . Although no nests have been found, three other species that could nest in the area include: the Northern harrier, American kestrel, and short-eared owl. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treaty Act (16 USC, § 703 et seq.) and Wyoming Statute (WRS 23-1-101 and 23-3-108). The golden eagle is also afforded additional protection under the Bald Eagle Protection Act, amended in 1973 (16 USC, § 669 et seq.).

Data from aerial surveys conducted during the spring of 1996 revealed a total of 170 raptor nests that were identified within or proximal to the 273-square-mile Greater Cave Gulch Raptor Analysis Area (Figure 3-11). Fifty-two of the 170 raptor nests are located within the project area. Nest site locations and status of these 52 nests are depicted in Figure 3-11 and described in Table 3-18. Of these, 42 (81%) were those of ferruginous hawks, 4 (8%) were those of golden eagles, 4 (8%) were those of red-tailed hawks, one (2%) of a great-horned owl, and one (2%) was a prairie falcon eyrie. Most of these nests are located in the badland habitat which trends northwest-southeast through the central portion of the project area or along the steep banks of main drainages where adequate natural nesting sites exist.

Of the 52 raptor nests located within the project area, 9 (17.3%) were occupied, for at least some time, during the 1996 nesting season. And of these 9 nests, only 2 nests (1 golden eagle, and 1 great-horned owl) were known to be successful in producing at least one bird to fledging age. Two other nests were visited by ferruginous hawks (No. 4 and No. 26), but were not occupied. Five nests (2 ferruginous hawks, 1 golden eagle, and 2 red-tailed hawks) failed, leaving abandoned eggs or no surviving young, and 2 of the occupied nests (1 red-tailed hawk and 1 prairie falcon) were not checked during the fledging period and were recorded as having an undetermined production status (Table 3-19). Field observations during 1996 were not extensive enough to document fledging success or cause of nest failure.

3.7.2.4 Nongame Birds and Mammals

A variety of small nongame birds and mammals are found on the project area. Major small nongame songbirds include horned larks, sage sparrows, Brewer's sparrows, and vesper sparrows. The principal small mammals found on the project area include voles, deer mice, least chipmunks, Wyoming ground squirrels, white-tailed jackrabbits, and desert cottontails.

Table 3-18. Location, Condition, and Activity Status of Raptor Nests Found within the Cave Gulch-Bullfrog-Waltman Project Area.

NEST NO.	SPECIES	LEGAL LOCATION	NEST COND	NEST SUBSTRATE	STATUS[1]		
					1994	1995	1996
1	Ferruginous Hawk	NE SW SE Sec 25 T37N:R87W	Poor	rock	no	no	no
2	Golden Eagle	SE SE NE Sec 31 T37N:R86W	Good	cliff	no	visited	visited
3	Ferruginous Hawk	NE SW SW Sec 30 T37N:R86W	Good	rock	no	visited	no
4	Ferruginous Hawk	NE SE SW Sec 30 T37N:R86W	Good	rock	no	visited	visited
5	Golden Eagle	NE NW NE Sec 8 T36N:R86W	Good	cliff	no	no	PROD
6	Ferruginous Hawk	NW NE NE Sec 31 T37N:R86W	Fair	rock	no	no	no
10	Ferruginous Hawk	NW NE SW Sec31 T37N:R86W	Fair	rock	no	no	no
11	Ferruginous Hawk	SW NE SW Sec 32 T37N:R86W	Fair	rock	no	no	no
12	Ferruginous Hawk	NW SW SE Sec 32 T37N:R86W	Fair	rock	no	no	no
13	Ferruginous Hawk	SE SE NE Sec 31 T37N:R86W	Poor	rock	no	no	no
14	Red-tailed Hawk	NE SE NW Sec 30 T37N:R86W	Fair	rock	no	failed[2]	failed
15	Ferruginous Hawk	SE NW SE Sec 32 T37N:R86W	Good	rock	no	tended	no
17	Ferruginous Hawk	SE SE SE Sec 30 T37N:R86W	Poor	rock	no	no	no
18	Ferruginous Hawk	NE NW NE Sec31 T37N:R86W	Poor	rock	no	no	no
19	Ferruginous Hawk	NW NE SW Sec 30 T37N:R86W	Poor	ground	no	no	no
20-a	Golden Eagle	NW NE SW Sec31 T37N:R86W	Fair	cliff	no	no	failed
20-b	Great-horned Owl	NW NE SW Sec31 T37N:R86W	Good	cliff	no	no	PROD
21	Ferruginous Hawk	SE SW NW Sec 5 T36N:R86W	Poor	rock	no	no	no
22	Ferruginous Hawk	NE NE NW Sec 5 T36N:R86W	Fair	rock	no	no	no
23	Ferruginous Hawk	SW SE SE Sec 6 T36N:R86W	Poor	rock	no	no	no
24	Ferruginous Hawk	NW SW SE Sec31 T37N:R86W	Poor	rock	no	no	no
25	Ferruginous Hawk	SW SE NE Sec 6 T36N:R86W	Poor	rock	no	visited	no
26	Ferruginous Hawk	NE SE NE Sec 6 T36N:R86W	Good	rock	no	tended	visited
27	Golden Eagle	NW SW NE Sec 8 T36N:R86W	Good	cliff	no	no	no
28	Ferruginous Hawk	SW SW SE Sec 12 T36N:R87W	Good	rock	–	no	no
29	Ferruginous Hawk	NW NW NE Sec 13 T36N:R87W	Poor	rock	no	no	no
30	Ferruginous Hawk	SW NW NE Sec 13 T36N:R87W	Good	rock	no	no	no
31	Ferruginous Hawk	NW SW NE Sec 13 T36N:R87W	Good	rock	no	no	no
32	Ferruginous Hawk	SE NW SE Sec 13 T36N:R87W	Good	rock	no	tended	no
33	Ferruginous Hawk	SE SW SE Sec 13 T36N:R87W	Good	rock	–	no	no
34	Ferruginous Hawk	SE SW SE Sec 13 T36N:R87W	Good	rock	no	no	failed
35	Ferruginous Hawk	SE SW SW Sec 14 T36N:R87W	Fair	ground	no	no	no
36	Ferruginous Hawk	NE NW NW Sec 25 T36N:R87W	Good	ground	–	no	no
40	Ferruginous Hawk	NE SW NW Sec 24 T37N:R87W	Fair	ground	–	no	no
41	Ferruginous Hawk	NE SW NW Sec 24 T37N:R87W	Good	rock	–	failed	no

Table 3-18. Continued.

NEST NO.	SPECIES	LEGAL LOCATION	NEST COND	SUBSTRATE	STATUS[1] 1994	1995	1996
42	Ferruginous Hawk	NW SW SW Sec 19 T37N:R86W	Poor	ground	--	no	no
43	Red-tailed Hawk	SW NE SW Sec 19 T37N:R86W	Good	tree	--	no	failed
44	Red-tailed Hawk	NE NW SW Sec 21 T37N:R86W	Fair	tree	--	no	no
45	Ferruginous Hawk	SW SE NE Sec 29 T37N:R86W	Good	ground	--	no	no
66	Ferruginous Hawk	NW NE NE Sec 26 T36N:R87W	Poor	ground	--	--	no
68	Red-tailed Hawk	NW NE SW Sec 33 T37N:R86W	Good	rock	--	--	occupied
70	Ferruginous Hawk	SE NW SW Sec 8 T36N:R86W	Fair	bank	--	--	no
71	Ferruginous Hawk	NE SW SW Sec 8 T36N:R86W	Good	bank	--	--	no
72	Ferruginous Hawk	SW NW NE Sec 17 T36N:R86W	Good	pillar	--	--	failed
73	Prairie Falcon	SE NW SE Sec 8 T36N:R86W	Good	pillar	--	--	occupied
105	Ferruginous Hawk	NE NW SE Sec 07 T36N:R86W	Poor	bank	--	--	no
138	Ferruginous Hawk	NW NE NW Sec 23 T36N:R87W	Fair	ground	--	--	no
139	Ferruginous Hawk	NW SW NE Sec 22 T36N:R87W	Good	ground	--	--	no
140	Ferruginous Hawk	NW SE SE Sec 27 T36N:R87W	Fair	ground	--	--	no
172	Ferruginous Hawk	SE SW NE Sec 24 T37N:R87W	Fair	rock	--	--	no

[1] no = not occupied - no bird, eggs, or young
occup = at least one egg laid or bird in incubating position.
visited = bird standing on nest.
prod = productive - produced at least one young to fledging age.
tended = bird sitting in nest or building onto nest - no eggs laid.
failed = abandonded eggs in nest or no surviving young.
-- Nest not found or not checked
[2] Ferruginous hawk nest used by a Canada goose.

Table 3-19. Number and Status of Raptor Nests within the Cave Gulch-Bullfrog-Waltman Project Area (HWA 1996).

	Nests[1]									
	Total		Occupied		Productive		Failed		Undetermined	
Species	Number	%[2]	Number	%[3]	Number	%[4]	Number	%[4]	Number	%[4]
Ferruginous Hawk	42	80.8	2	4.8	0	0	2	100	0	0
Golden Eagle	4	7.7	2	50	1	50	1	50	0	0
Red-tailed Hawk	4	7.7	3	75	--	--	2	66.7	1	33.3
Prairie Falcon	1	1.9	1	100	--	--	--	--	1	100
Great-horned Owl	1	1.9	1	100	1	100	0	0	0	0
Grand Total	52	100	9	17.3	2	22.2	5	55.6	2	22.2

[1] Occupied - At least one egg laid or bird in incubating position.
Productive - Produced at least one young to fledging age.
Failed - Abandonded eggs in nest or no surviving young.
Undetermined - Occupied nests which were not checked for fledgling status.
[2] Percent of grand total.
[3] Percent of species total.
[4] Percent of occupied nests of that species.

3.7.3 Special Status Wildlife Species

Special status wildlife species include those listed as threatened or endangered under the federal Endangered Species Act (ESA) of 1973 as amended, species proposed for federal listing, "species at risk" (formerly C2 and 3C candidate species), and other species identified either by the BLM, FWS, or WYNDD as unique or rare which have the potential for occurrence within the project area. On July 19, 1995, the FWS issued a new policy which exempted C2 and 3C candidate species from listing under the ESA. Consequently, former C2 candidates are referred to as "species at risk", while 3C species retain no status. While these former candidate species are afforded no legal status under the ESA, it is within the "spirit" of the ESA to consider the impact of a proposed action on these species as well. The material presented in this section and that presented in Chapter 4, along with other appropriate materials in this EIS, are intended to satisfy the requirements for a Biological Assessment (BA) of potential impacts to these species. Accounts of individual species follow.

The FWS has determined that one species, listed as endangered under the ESA, and two species designated as Category C1 wildlife species, have the potential to occur on or in the vicinity of the project area (FWS 1996; Appendix F). These three species are listed below in Table 3-20.

Table 3-20. Special Status Wildlife Species Potentially Present in the Cave Gulch-Bullfrog-Waltman Project Area.

Species	Scientific Name	Status
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Swift fox	*Vulpes velox*	C1
Birds		
Mountain plover	*Charadrius montanus*	C1

<u>Black-footed ferret and associated white-tailed prairie dog colonies.</u> The black-footed ferret's original distribution in North America closely corresponded to that of prairie dogs (Hall and Kelson 1959, Fagerstone 1987). In Wyoming, white-tailed prairie dog (*Cynomys leucurus*) colonies provide essential habitat for black-footed ferrets. Ferrets depend almost exclusively on prairie dogs for food and they also use prairie dog burrows for shelter, parturition, and raising their young (Hillman and Clark 1980, Fagerstone 1987).

Although no formal searches for prairie dogs have been conducted, no prairie dogs or prairie dog towns were observed on the project area during three years (1994-1996) of field work. Based on the lack of prairie dog sightings, during thorough coverage of the study area by both consultant and BLM biologists, it is unlikely that suitable habitat for black-footed ferrets occurs on the project area. In addition, no black-footed ferret sightings within the project area have been reported in the WOS, WYNDD, or the records of the FWS.

Swift Fox. The swift fox inhabits short grass and mid-grass prairies over most of the Great Plains including eastern Wyoming (Clark and Stromberg 1987). In eastern Wyoming and portions of northeastern Colorado, the species is most common in areas with relatively flat to gently rolling topography (Fitzgerald et al. 1994). Dens are typically located on sites dominated by blue grama or buffalograss. Swift foxes prey on a variety of small rodents, lagomorphs, and birds, although lagomorphs comprise the majority of their diet (Cutter 1958).

This species has been little studied in Wyoming, but recent surveys conducted by Woolley et al. (1995) show that it is much more widely distributed than previously thought. Woolley's studies have documented several occurrences in eight counties in Wyoming including west central Natrona County. Several observations of swift fox were made within 11 miles south of the project area. In addition, several responses from trapper surveys indicate the presence of swift fox in the vicinity of the project area. In consideration of this information and the fact that the project area lies near the western edge of historic swift fox range (Long 1965), it appears likely that the swift fox may be found on and proximal to the project area.

Mountain Plover. The mountain plover nests over much of Wyoming, but preferred habitat is limited throughout its range (Oakleaf et al. 1982, Dinsmore 1983, Leachman and Osmundson 1990). Mountain plovers prefer shortgrass prairie with open, level or slightly rolling areas dominated by blue grama and buffalograss (Graul 1975, Dinsmore 1983, Kantrud and Kologiski 1982). These habitats are quite often associated with prairie dog colonies and researchers have found that plovers select prairie dog colonies over other areas (Knowles et al. 1982, Knowles and Knowles 1984, Olson and Edge 1985). In Montana, breeding populations of plovers are primarily confined to prairie dog colonies in the north central portion of the state (Knowles and Knowles 1984).

The project area is dominated primarily by mixed desert shrub and to a lesser degree, badland breaks habitats which are habitats that are not preferred for nesting by plovers. Prairie dog colonies do not occur on the project area and there have been no reports of mountain plovers recorded for the project area in either the WOS or WYNDD. In consideration of the lack of preferred habitat on the area and the lack of evidence of occurrence, it is concluded that the use of the project area by mountain plovers is unlikely.

3.8 RECREATION

Recreation in the project area involves dispersed activities; there are no developed recreation sites. There is a South Bighorn/Redwall National Backcountry Byway sign at Waltman across from the store and one BLM interpretive facility on the west side of Natrona County Road 104 introducing motorists to the Backcountry Byway. The Backcountry Byway is used by many summer visitors to access the southern Bighorn Mountains and by hunters in the fall. However, no specific data on the exact number of Byway users is available.

Recreation uses in the project area are concentrated during the hunting seasons. The area provides antelope and some mule deer hunting opportunities. Pronghorn hunting in the area generally occurs during September, with the mule deer season occurring in October. the area also attracts some small game hunters pursuing rabbits and sage grouse on the north edge of the project area. Although data on recreation visitations to the project area are not available, overall recreation use levels in the area are generally low. A number of factors appear to be the cause for low use rates, including no special feature to attract users, limited numbers of local residents, long travel distances from populated areas, and other equally accessible sites in the region with more amenities. There may be occasional use of the area for hiking, wildlife observation, geologic observation, and nature photography.

A very important use of the project area is scenic touring. The south entry onto the South Bighorn/Redwall National Backcountry Byway passes through the middle of the project area. Observing landscape scenery (including the project area), as well as wildlife is an important component of the recreation experience for many users who travel the Byway. Most Byway users are headed north into the Bighorn Range. The Waltman Area is the gateway to their recreation experience. The Byway offers interesting glimpses of the Bighorn Mountains particularly from the north Byway interpretive facility pullout. Use of the Byway begins with good weather in May and continues through the hunting season in October. Heaviest use appears to occur during the June through August "tourist season".

3.9 VISUAL RESOURCES

The following description of the affected environment is based on the BLM land classification program for Visual Resource Management (VRM) (USDI-BLM 1980). An estimated 65% of the project area is typical of the Wyoming short grass prairie, a Class C scenic quality. The characteristic landscape is gently undulating, generally rising to the north. A cluster of badland breaks and fins in the Bullfrog unit is partially visible from Natrona County Road 104. The badlands/fins complex has the highest scenic quality of any location within the study area. An estimated 6,000 acres within this complex have been identified as having a Class A scenic quality and an additional 2,500 acres of Class B quality VRM (USDI-BLM 1990). Class B areas within the badlands/fins complex exist where existing oil and gas development have diminished the quality of the visual resource. However, as illustrated in Figure 3-12 an estimated 75% of these areas of higher scenic quality are seldom seen from County Road 104. Several small playas add contrast and two stock watering ponds on the western edge of the site area are also visible from County Road 104. The entire study area is within the foreground/middleground of the viewshed from Highway 20/26 and County Road 104.

Shrubs are visually subordinate to grasses within the project area but occasionally form visible patterns around playas and in drainage ways. There are few if any trees. The dominant visual impression presented by the project area is fine-textured, grass-covered, undulating hills, with a naturally contrasting badlands area. With the exception of this badlands area, the topography is relatively unbroken and the visual absorption capacity is very low. The topographic diversity of the badland breaks and fins in the Bullfrog Unit provide screening and background that increase the visual absorption capacity to moderate or high levels.

An estimated 16 square miles of the project area is visible from Wyoming Highway 20/26 in the foreground and middleground of the viewshed. Large sections of the badlands located in the northeast quadrant of the project area are seldom seen. Several factors produce the seldom seen sections including intervening topography, a 100-foot to 200-foot drop in the base plain elevation below the roadway, and long sight distances (3 to 4 miles in some cases). Over 50% of Section

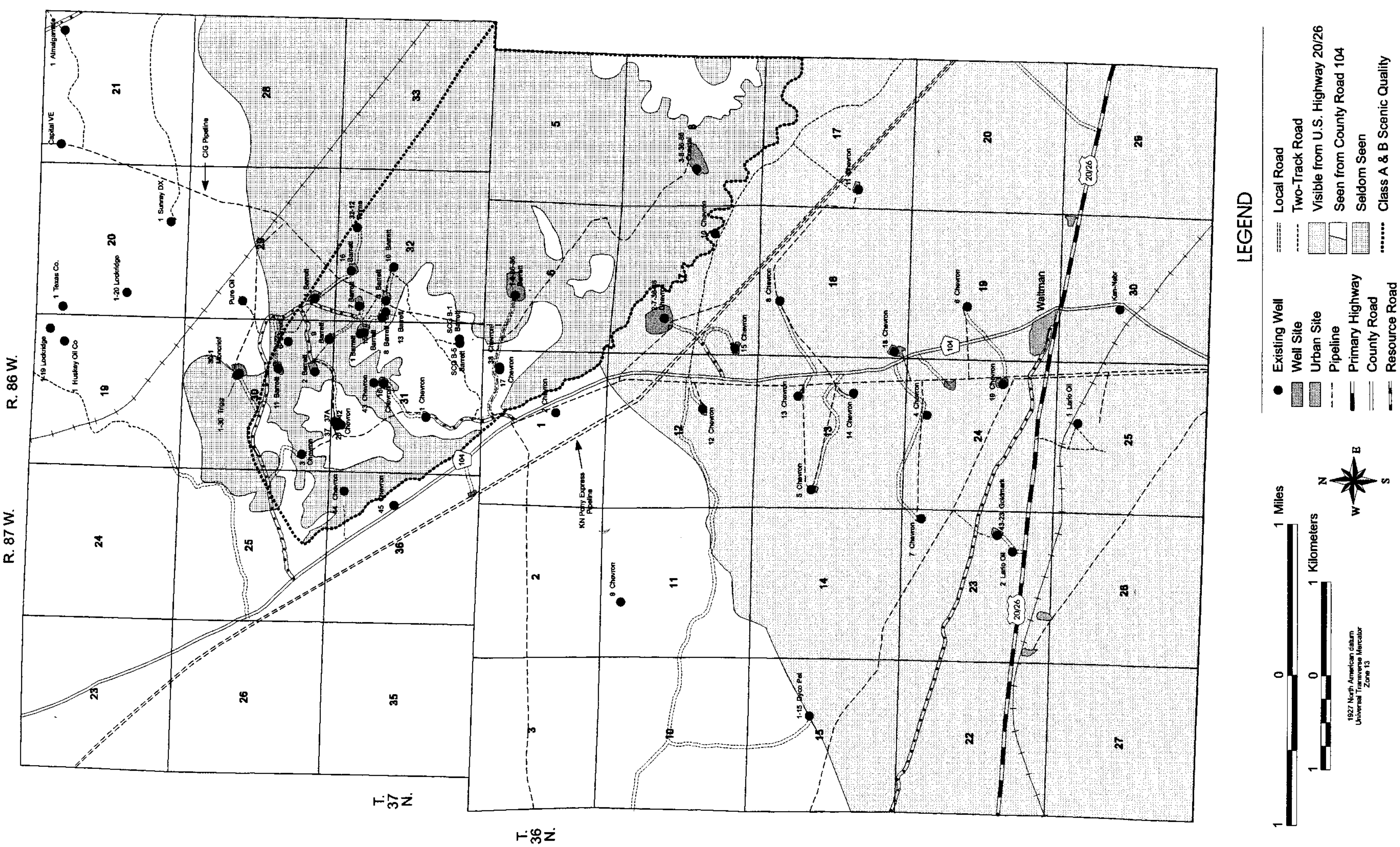


Figure 3-12. Visibility Zones and Existing Energy and Urban Development within the Cave Gulch-Bullfrog-Waltman Project Area.

30, 20% of Section 31, and 90% of Section 32 would seldom be seen from Natrona county Road 104 (Figure 3-12).

Dominant colors by season are dark green and gray-green in the spring and summer with occasional pink, blue, white, and yellow accents from flowering forbs. Yellow sweet clover dominates in the road and pipeline ROWs creating highly visible and unnatural appearing yellow lines in the landscape in mid-summer. Vegetation colors change to buffs and tans in the late summer, and remain as a background to the dominant white of winter snow. Soils vary in color from buff to gray with some areas of reddish color. The badlands are much richer in color than the adjacent landscape.

The project area is not pristine. Cultural modifications to the natural landscape described above include 2 power transmission lines, an auto junk yard, oil and gas equipment, a power substation, well sites, access roads, ranch out-buildings, and a railroad grade. The majority of these modifications are visible from the South Bighorn/Redwall National Backcountry Byway.

Tourist traffic on Wyoming Highway 20/26 is relatively high during the summer months. Destinations include the Wind River Range and Grand Teton and Yellowstone National Parks. The National Backcountry Byway is used by recreationalists accessing the southern end of the Bighorn range. The project area itself receives some use by recreationalists, primarily big game hunters in the fall. The quality of the visual resource is typically an area of concern for this user group. Equally sensitive would be the small number of residents (estimated population less than 50) in the town of Arminto, Wyoming who look directly into the project area. Other users of the area include those working in the oil and gas industry. Grazing permit holders would also be affected by changes to the visual resources.

The intent of the BLM's VRM Program is to preserve scenic values in concert with resource development. Visual resource specialists with the BLM have classified the visual resources in the project area as 100 percent Class 4 as shown in Figure 3-12. The VRM Program (USDI-BLM 1980) describes the levels of change to the visual resource permitted in Class 4 landscapes:

> Any contrast attracts attention and is a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color and texture of the characteristic landscape.

For a Class 4 area, projects that contrast enough to attract attention and dominate the landscape are allowed, but they should be constructed in a manner that they might seem to have been a natural occurrence.

3.10 CULTURAL RESOURCES

3.10.1 Cultural Resource Data Base

According to the information obtained from the Wyoming SHPO Cultural Records Office, there have been 34 projects in the project area which required Class III cultural resource inventories. Twenty-eight of the projects were related to oil and gas exploration and development, including 16 well locations (14 with access roads), 10 pipelines, and 2 access roads. Those projects not related to oil and gas include two Abandoned Mine Lands reclamation projects, two powerlines, one fence, and one historical sites inventory project. A majority of these projects (N=54) have been undertaken since 1990, signifying the increase in oil and gas activity in the area in the last six years.

The Cultural Records Office information also indicates that there have been 87 cultural sites recorded in the 35 sections of the project area, including 66 prehistoric, 16 historic, and 5 combined prehistoric/historic sites.

The most common site types or categories in the project area are the remains of prehistoric aboriginal campsites which include those in the categories of Artifact and Features (N=34), Lithic Scatters (N=25), and Stone Circles (N=8). Other prehistoric sites include those in the categories of Cairns (N=2) and Rock Art (N=1) (note: the prehistoric component of the prehistoric/historic sites are counted here also). Many of the sites that define one type have features of the other types; that is, a stone circle site may also have artifacts and hearths or a lithic scatter associated with it. Furthermore, the Artifact and Features site type may only be a lithic scatter with the addition of a concentration of fire-cracked rock or hearth.

Historic sites are less numerous in the area but include those in the categories of Debris Scatters (N=7), Stockherding Camps (N=5), Ranch Buildings (N=3), Mines (N=1), Corrals (N=1), Railroad Grades (N=1), Trails and Trail Crossings (N=2) and a Historic Community (N=1). Within these general categories are four major historic sites or features, all of which are located in the southern portion of the project area. These are the Bridger Trail, the Chicago and Northwestern Railroad grade, Waltman Crossing, and the old community of Waltman. Waltman Crossing is associated with the Bridger Trail and a stage route of the late 19th century. All of these are either eligible for or listed on the National Register of Historic Places.

Table 3-21 summarizes the National Register (NRHP) status of the sites within the project area. As indicated, the majority (71percent) of prehistoric sites are considered ineligible for listing on the National Register, while small proportions of the prehistoric sites are considered eligible (14 percent) or listed as unknown (15 percent). Although not usually specified in the records, with some exceptions, the major distinguishing criteria between eligible and ineligible prehistoric sites is the presence or absence of chronological or culturally diagnostic artifacts and datable materials in some patterned context. Thus, the eligible sites will generally have artifacts which indicate their age and cultural affiliation (e.g. 48 NA 2353 which is a Late Archaic site dating to 2300 B.C.), and/or contain hearths or other features with material suitable for radiocarbon dating, and/or have features indicating some kind of activity pattern (e.g. stone circles or tipi rings). Ineligible prehistoric sites generally lack these characteristics, and those categorized as "unknown" usually require further study or analysis to determine eligibility. Exceptions to these may be sites with rock art, human burials, or rock alignments which have significance under other National Register criteria.

Since most of the cultural resources inventory work in the area has been in response to increased energy exploration, most of the sites have been recorded in the areas where oil and gas activity has been the most intensive.

Table 3-21. National Register Eligibility Status of Cultural Sites in the Project Area

	Prehistoric Sites	Historic Sites	Prehistoric/ Historic Sites	Total
Eligible	9	5	2	16
Ineligible	47	10	2	59
Unknown	10	1	1	5
Total	66	16	5	87

Because the inventories have been concentrated in the sections with breaks-badlands (upper Cave Gulch), it would be meaningless to attempt to extrapolate data such as site densities and site distribution patterns from that terrain and apply it to other areas with quite different terrain. However, there appears to be a general trend for prehistoric sites to be more numerous in the areas with topographic diversity; that is, on or near stream terraces or benches, rock outcrops and escarpments, and ridge crests, such that occur along Cave Gulch. This trend is found throughout the region and is undoubtedly related to the desire for prehistoric hunters and gathering people to maximize their opportunities to acquire resources (shelter, water, game, plant foods, etc,) and minimize their effort and risks to get them. Based on this general trend, therefore, the prehistoric site density of the Cave Gulch or central portion of the project area should be higher than that of the northern and southern portions of the project area.

The distribution of historic sites is probably more dependent on historical factors than on proximity to resources. For example, the Bridger Trail, Waltman Crossing, old Waltman, and the Chicago and Northwestern Railroad all occur along a transportation corridor established very early in the Euro-American settlement of the area. Ranches and stockherding camps would be located where resources would be available for livestock, and are sometimes in the same places as prehistoric aboriginal sites because livestock and game require similar resources.

3.10.2 Summary

In summary, the project area exhibits an exceptionally high site density, with a potential for sites to be present in any or all of the topographic contexts in the study area. An undetermined number of these sites may contain the amount and variety of cultural materials to be eligible for nomination to the National Register of Historic Places.

3.11 SOCIOECONOMICS

3.11.1 Study Area

The socioeconomic study area for this analysis includes Natrona County, Wyoming and its communities. This section provides information about current economic, population, housing, public infrastructure and local government fiscal conditions within the study area.

The City of Casper, located approximately 50 miles from the project area, is the principal center of economic activity in central Wyoming. It is also the Natrona County seat and the largest community in the County. Other Natrona County communities surrounding Casper which could be affected by the project include Evansville, Bar Nunn, Mills, and the unincorporated towns of Arminto, Waltman, Powder River, Hiland and Natrona.

3.11.2 Socioeconomic Trends and Influences

Socioeconomic conditions in Natrona County have been shaped by the energy boom and bust cycle which has occurred over the last 20 years. The Organization of Petroleum Exporting Countries' (OPEC) oil embargo of the 1970s and the resultant energy boom in Wyoming led to rapid population growth in Natrona County and the emergence of the City of Casper as a regional oil and gas service center. Because of the dominance of the oil and gas industry, Casper and Natrona County were among the areas which were most severely affected when oil and gas prices fell in the mid-1980s. High unemployment, population out-migration, vacant housing units and declining property values were a direct result of the energy bust. Under-used public facilities and substantial reductions in local and state government revenues were among the indirect effects.

Although both employment and population have increased in the five years preceding this analysis, total employment and population are still substantially below the peak levels of the 1980s. The result is that the existing community infrastructure in Natrona County and the City of Casper could accommodate substantial growth.

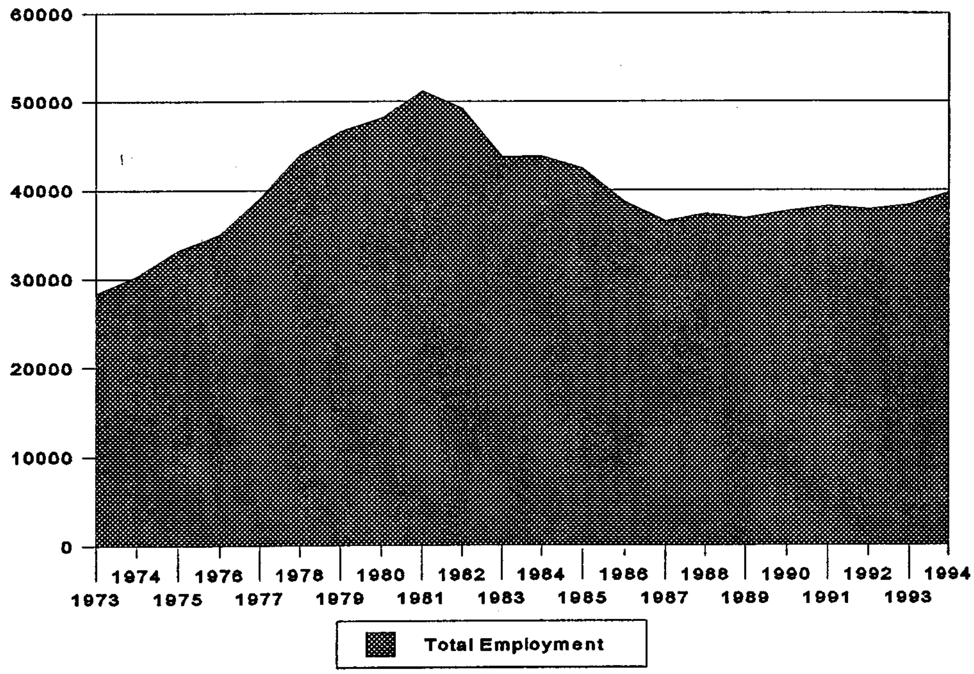
3.11.3 Local Economy

3.11.3.1 Employment, Unemployment, and Labor Force

Figure 3-13 displays total Natrona County full- and part-time employment for the 1973 through 1994 period. The figure illustrates the economic boom and bust cycle which occurred over the last two decades.

Natrona County employment increased dramatically during the 1970s as the City of Casper emerged as a regional center for oil and gas exploration and development. During this period, major oil companies such as Amoco, Texaco, Chevron, Conoco and Marathon established or expanded regional offices in the City. Consequently, total employment increased from 28,316 in 1973 to 51,150 in 1981, an increase of 80 percent over the 8 year period.

Figure 3-13. Natrona County Full- and Part-Time Employment.



Source: 1996 Wyoming Division of Economic Analysis

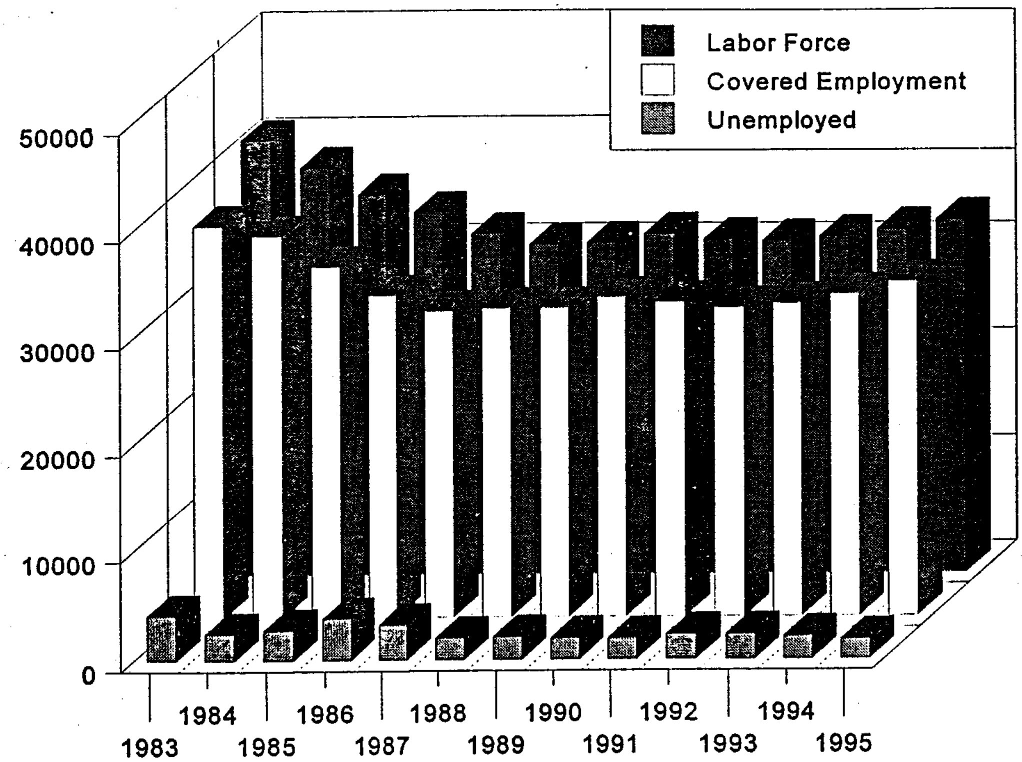
When OPEC slashed oil prices in 1982, the incentive to explore for domestic oil began to subside. The ensuing "energy bust" caused substantial social and economic upheaval in Casper, Natrona County and much of Wyoming. Between the peak of 1981 and the trough of 1987, total Natrona County employment fell from 51,015 jobs to 36,403 jobs, a loss of 29 percent over the 6 year period. Full- and part-time employment in the County increased moderately (5.6 percent) between 1990 and 1994, but total employment remains well below the 1981 peak.

Natrona County covered employment (jobs in which the worker is covered by unemployment insurance), civilian labor force, and unemployment data are illustrated in Figure 3-14. The corresponding data for this figure are presented in Table 3-22.

The post-1982 retrenchment in the oil and gas industry resulted in significant unemployment in the State of Wyoming in general and in Casper and Natrona County in particular. The State unemployment rate peaked at about 8 percent in 1986, while the Natrona County unemployment rate peaked at 11.3 percent (Wyoming Department of Employment 1996a).

As shown in Figure 3-14, periods of high unemployment were followed by reductions in the Natrona County labor force which, in turn resulted in substantial loss of population. Population effects will be discussed in the following section.

Figure 3-14. Natrona County Economy.

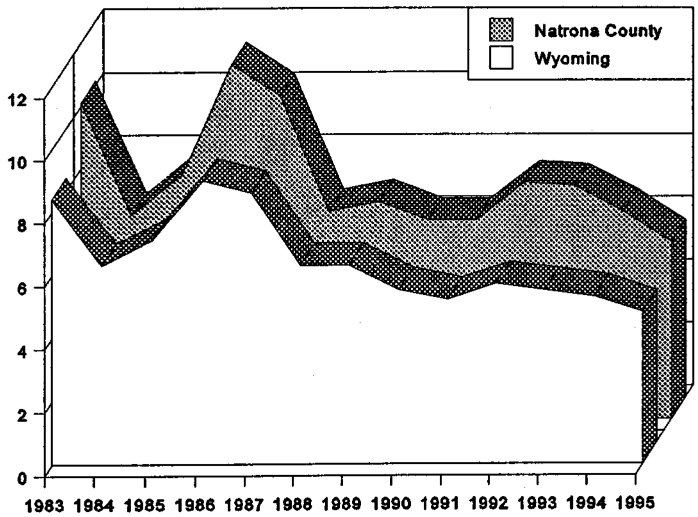


Source: Wyoming Department of Transportation. 1996a.

Figure 3-15 contrasts the average annual unemployment rate for Natrona County and the State of Wyoming as a whole. The unemployment rate in Natrona County was consistently higher than the State rate from 1983 to 1995, and the April 1996 monthly unemployment rate estimate for Natrona County was 6.3 percent while the Statewide unemployment rate was 5.2 percent (Trends 1996).

Compounding this dramatic decline in employment and concurrent increases in unemployment was the fact that many of the jobs lost were in relatively high paying industries. The cutback in oil and gas exploration, development and production coupled with refinery closures and the exit of regional offices of major oil companies eliminated a substantial number of higher-wage jobs in the County.

Figure 3-15. Unemployment Rate Comparison.



Source: Wyoming Department of Employment. 1996a.

3.11.3.2 Historic Trends in Key Components of the Local Economy

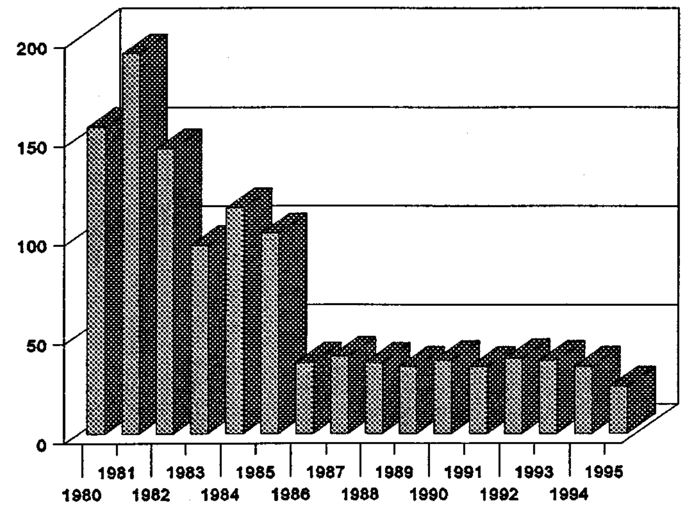
3.11.3.2.1 Oil and Gas

Drilling statistics are a key indicator of activity in the oil and gas industry. The average number of drilling rigs operating in Wyoming has declined significantly since the peak of the early 1980s, as illustrated in Figure 3-16. The average rig count in Figure 3-16 is an annual average based on the daily rig count.

In addition to the general decline in drilling, there has also been a shift in drilling objectives. During the 1970s and early 1980s, most drilling in Wyoming targeted oil bearing formations. In recent years, much of the drilling activity has been for natural gas. Natural gas production is typically less labor-intensive than oil production. Oil production typically requires more employment due to the transportation of product by truck rather than pipeline and the increased maintenance required on the pumpers and other surface facilities. Industry employment has likely been severely affected by the decline in drilling activity and the shift to natural gas production.

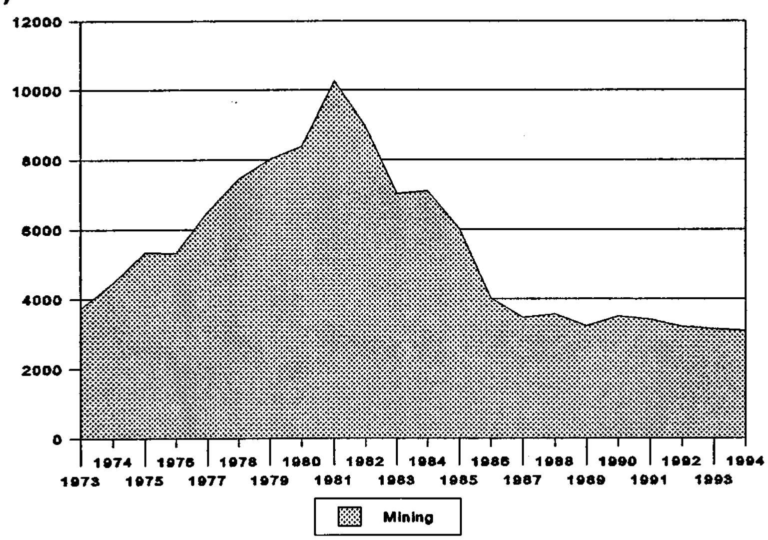
The state-wide reduction in drilling activity resulted in substantial loss of employment for Natrona County. Figure 3-17 displays Natrona County mining (including oil and gas) employment for the 1973 through 1992 period. Natrona County mining employment grew from 3,709 jobs in 1973 to 10,260 jobs in 1981, a 177 percent increase over the 8 year period. Mining employment then fell to 3,230 by 1989, a decrease of 68 percent in 8 years. Consequently, 1989 employment in the Natrona County mining sector was about 13 percent lower than 1973 employment in that sector.

Figure 3-16. Average Rig Count for Wyoming.



Source: Wyoming Geological Survey, 1996.

Figure 3-17. Natrona County Full- and Part-Time Mining Employment (including oil and gas).

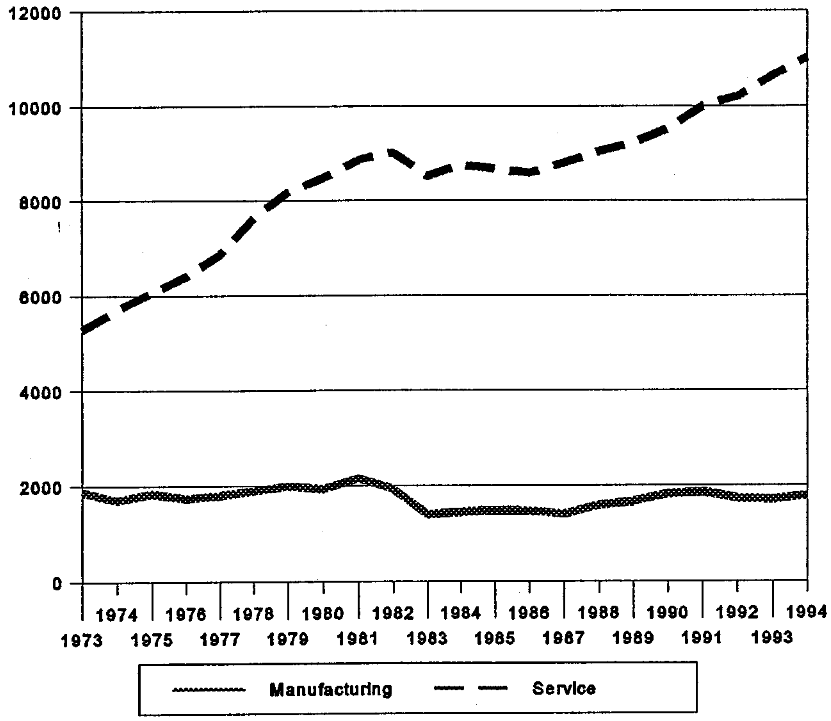


Source: 1996 Wyoming Division of Economic Analysis

3.11.3.2.2 Other Economic Sectors

Figure 3-18 displays 1973 through 1994 full and part time employment for the Natrona County manufacturing and service sectors. Manufacturing has been less volatile than mining in Natrona County. Manufacturing employment grew from 1,875 in 1973 to 2,154 in 1989, an increase of 15 percent. From the peak, manufacturing employment declined to a low of 1391 in 1993, a 35 percent loss, and then rebounded to 1,662 by 1989, a 19 percent increase over the low point.

Figure 3-18. Natrona County Manufacturing and Service Sector Employment: 1973-1994.



In contrast, Natrona County service sector employment has shown annual increases in all but one year during the 1973 through 1989 period, ending at 9,226 for a 75 percent increase over the 1973 level of 4,848.

3.11.3.3 Current Economic Conditions and Near-Term Projections

Data for 1990 to 1994 full- and part-time employment by major industrial sector for Natrona County are displayed in Table 3-22 (WYDEA 1995b).

The Natrona County economy has experienced slow, steady employment growth for the last several years, as demonstrated by the 1995 unemployment rate which fell to 5.6 percent. This is in part a result of the emerging diversification of the Casper/Natrona County economy. For example, a number of manufacturing firms have located in Casper in recent years, including ExCal, West Coast Stainless, and Defense Technologies.

Despite this recent diversification, the local economic base remains primarily dependent on oil and gas, agriculture and tourism. Except for the manufacturing jobs noted above, many of the jobs created in recent years have been in the service sector which typically offers lower wages than energy-related jobs.

Table 3-22. Full-Time and Part-Time Employment in Natrona County.

Employment Sector	1990	1991	1992	1993	1994
Farm Employment	438	423	427	462	422
Agricultural Services	328	344	345	378	448
Mining	3,489	3,461	3,190	3,125	3,081
Construction	2,457	2,687	2,188	2,180	2,421
Manufacturing	1,822	1,872	1,744	1,698	1,788
Transportation & Pub. Utilities	1,950	1,960	1,904	1,928	2,019
Wholesale Trade	2,335	2,337	2,330	2,404	2,422
Retail Trade	6,995	7,175	7,451	7,597	7,737
Finance, Ins. & Real Estate	3,028	2,752	2,595	2,609	2,814
Services	9,522	10,102	10,166	10,642	11,017
Government	5,185	5,233	5,434	5,250	5,484
Total Employment	37,549	38,346	37,774	38,273	39,653

Source: Wyoming Division of Economic Analysis (1996b and c).

3.11.3.3.1 Oil and Gas

Employment in the Natrona County mining sector has continued to decline in recent years, falling another 11.7 percent between 1990 and 1994. However, employment in the Natrona County oil and gas industry has decreased even more dramatically than the mining sector as a whole, according to figures provided by the Wyoming Department of Employment. These estimates, which are derived from Wyoming Department of Employment covered employment statistics, are presented in Table 3-23. The estimates reflect a decrease of more than 21 percent in Natrona County oil and gas employment from 1990 to 1995. This decrease in employment has been caused by a combination of declining oil production in the aging oil fields in the Casper vicinity and a general decrease in exploration activity in the state. It should be noted that some workers employed in oil and gas exploration and development activities such as truck drivers may not be included in the employment figures presented in Table 3-23. Consequently total oil and gas industry employment losses are not reflected in these statistics.

Table 3-23. Natrona County Oil and Gas Extraction Employment Covered by Unemployment Insurance (SIC 13).

	1990	1991	1992	1993	1994	1995
Natrona County	2,290	2,224	2,108	2,056	1,914	1,794
Wyoming Total	8,941	8,856	8,273	8,767	8,757	n/a

Source: Wyoming Department of Employment, Research and Planning Division (1996b).

The Natrona County drilling statistics help explain the reductions in oil and gas employment. The number of approved permits to drill (APDs) and wells actually drilled in Natrona County during the 1991 to 1995 period are illustrated in Table 3-24. Although the actual number of wells drilled in the County has fluctuated, drilling has decreased substantially in recent years.

Table 3-24. Approved Permits to Drill and Wells Drilled in Natrona County.

Natrona County	1991	1992	1993	1994	1995
Approved Permits to Drill	78	87	37	63	75
Wells Drilled	61	73	15	44	39
Wells Drilled as a Percent of Permits	78.2%	83.9%	40.5%	69.8%	52.0%

Source: WOGCC Unpublished County Drilling Summaries 1991 to 1995.

Even though oil and gas employment remains well below 1981 levels, a substantial number of drilling, oil field equipment, field service and trucking firms remain in Natrona County. Casper remains a center for oil and gas services, and many of the firms located in the City serve oil and gas development throughout central Wyoming and other areas of the state. Consequently, the oil and gas drilling and service industry continues to be a significant component of the local economy.

3.11.3.3.2 Other Employment Sectors

From 1990 to 1994, employment in the retail trade and service sectors increased 10.6 percent and 15.7 percent, respectively. Employment in the construction and manufacturing sectors both decreased slightly, -1.5 percent and -1.9 percent, respectively. The employment figures for manufacturing reflect the closure of the Amoco refinery in Casper in 1991. This closure resulted in the loss of approximately 210 manufacturing jobs in the local economy; however, diversification of the local economy has replaced almost all of the jobs lost from the refinery closure.

3.11.3.3.3 Near-term Projections

Anticipated employment trends for Natrona County for the remainder of the decade include increases in the retail, services and wholesale sectors and continued declines in the mining sector (Black 1996). These projections reflect statewide trends with the exception that several counties in the State can anticipate increases in the mining sector where specific commodities are in demand.

3.11.3.4 Earnings

Nominal dollar (unadjusted for inflation) earnings by major industry shown in Table 3-25 include wage and salary income, other labor income, farm income and proprietor income (businesses organized as sole proprietorships or partnerships). Income earned in Natrona County increased 19.75 percent from 1990 to 1994. Over the same period, mining earnings increased 24.75 percent. Construction and manufacturing earnings were relatively flat over the period, decreasing 3.9 percent and increasing 1.6 percent, respectively. From 1990 to 1994, manufacturing income increased 29.2 percent, services income increased 29.9 percent and wholesale trade income increased 28 percent. Between 1990 and 1993, per capita personal income increased 13.9 percent. In 1994, Natrona County per capita personal income was $22,824 compared to Wyoming statewide per capita personal income of $20,378. Income earned by sector and per capita income are presented below in Table 3-25. Recent employment and income statistics support the conclusion that the local economy has diversified somewhat since 1990.

Table 3-25. Total Earnings by Major Industry ($000) and Per Capita Income in Natrona County, Wyoming.

Employment Sector	1990	1991	1992	1993	1994
Farm Earnings	3,002	9,136	9,630	14,208	6,313
Agricultural Services	2,601	3,377	3,764	4,294	4,647
Mining	165,233	183,471	187,500	196,246	206,122
Construction	58,598	64,016	52,065	50,904	56,326
Manufacturing	55,944	57,798	51,892	51,030	55,070
Transportation & Pub.. Utilities	52,403	55,322	58,568	57,500	58,700
Wholesale Trade	67,971	68,835	71,199	74,305	74,046
Retail Trade	85,943	89,495	96,286	100,847	106,062
Finance, Ins. & Real Estate	35,720	35,220	37,237	40,643	38,774
Services	161,072	176,690	194,841	211,742	221,953
Government	123,583	128,762	136,608	138,788	144,403
Total Earnings	812,070	872,122	899,590	940,507	972,416
Per Capita Personal Income	19,484	21,004	21,428	22,312	22,824

Source: 1995b Wyoming Division of Economic Analysis.

3.11.3.5 Underemployment and Multiple Job Holding

Many of the new jobs created in Natrona County since 1990 are in the (on-average) lower-paying service and retail sectors. Two current issues identified by Natrona County officials during the EIS scoping process were unemployment and underemployment of local workers.

Underemployment occurs when a worker is working in a job that does not require the worker's highest skill level and, consequently, does not pay as much as the worker could make if he or she were working at his or her highest skill level. According to Natrona County human service officials, many underemployed workers are required to seek multiple jobs to provide adequate income for themselves and their families (Heimer 1996, Royal 1996). It may also be economically necessary for more than one family member to work in families with an underemployed primary wage earner.

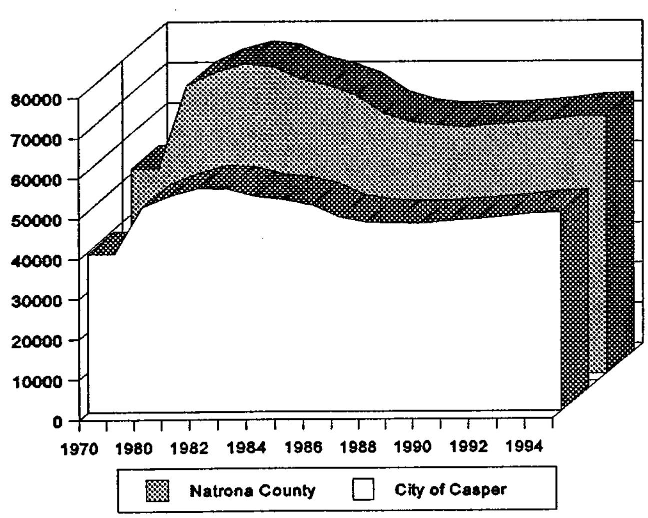
The U.S. Bureau of Economic Analysis (BEA) provides estimates of the total number of jobs in Wyoming and each of its counties in their full- and part-time employment figures. Dividing the BEA full- and part-time employment figure (an estimate of the number of jobs) for a particular area by the Department of Employment's employment figure (an estimate of the number of persons employed) for that jurisdiction produces an estimate of the number of jobs per employed person. This figure can be used to compare possible rates of multiple-job holding among different jurisdictions. The number of jobs per employed person in Wyoming for 1994 was about 1.247 while the comparable rate for Natrona County in 1994 was 1.316. This would tend to confirm the notion that multiple job-holding is more common in Natrona County than in most of Wyoming.

3.11.4 Population

During the past two decades, population growth and decline in Natrona County has been similar to that of the State of Wyoming. Both the County and the State experienced rapid growth during the period from 1970 through the early 1980s. From 1970 to 1982, the population of Natrona County increased from 51,264 to 77,097, an increase of more than 50 percent. Over the same period, the State's population increased from 332,416 to 506,423 an increase of more than 52 percent. After 1982-83, both Natrona County and the State of Wyoming lost population as a result of the steep decline in oil prices. However, the effects of the bust were substantially more severe in Natrona County than the State as a whole. Natrona County lost about 20.6 percent of its population from 1982 to 1990 while the State population declined by about 10.4 percent over the same period.

Figure 3-19 illustrates the loss of population which has occurred in Natrona County and the City of Casper in recent years.

Figure 3-19. Historic Population Estimates for Natrona County and the City of Casper, 1970-1994.



Sources: U.S. Bureau of the Census, Wyoming Division of Economic Analysis 1995a.

After the decline in the 1980s, Natrona County population has gradually increased. Based on estimates provided by the U.S. Bureau of the Census and the Wyoming Division of Economic Analysis (WDEA), the County's population has increased by about 5.4 percent between 1990 and 1995. Over the same period, the City of Casper experienced a population increase of about 5.8 percent. Recent population estimates for Casper, Bar Nunn, Evansville, Mills and Natrona County are presented in Table 3-26.

Table 3-26. Population Estimates for Natrona County and its Municipalities. Selected Years 1980 to 1995.

JURISDICTION	1970	1980	1982	1985	1990	1993	1995
Casper	39,361	51,016	55,567	52,736	46,765	48,415	49,473
Bar Nunn	n/a	n/a	782	801	835	892	902
Evansville	n/a	2,335	2,358	1,983	1,486	1,470	1,535
Mills	n/a	2,139	2,235	1,990	1,583	1,630	1,669
Natrona County, WY	51,264	71,856	77,097	71,566	61,226	62,923	64,025

Sources: U.S. Department of Commerce, Bureau of the Census, Wyoming Division of Economic Analysis 1995a.

3.11.5 Housing

3.11.5.1 Single and Multi-Family Homes

As with the local economy and population, Natrona County housing conditions have been shaped by the energy boom and bust. The Casper housing market had a surplus of housing units for most of the latter half of the 1980s. Since 1990, many of these units have been gradually absorbed; however, as of August 1996, a surplus of available homes for sale continued to exist in many price categories (Moore 1996). Approximately 450 Casper area residential housing units are currently listed with the Casper Multiple Listing Service. Prices for existing homes remain below the cost of construction but have risen substantially since 1990 (Barnard 1996).

As a consequence of the surplus of available housing units, relatively little new home construction has taken place in Casper over the past five years. According to Bureau of Census figures, only 335 new housing units were authorized for construction from 1990 to 1995 in Natrona County, compared to 1363 in Laramie County (WDEA 1996d) . Laramie County is used for contrast because it is a comparably-sized community and, with Natrona County, contains one of the two census metropolitan areas in the state. The WDEA data also indicates that most of the new units constructed in Natrona County were more expensive custom homes.

Houses for rent are relatively scarce in Casper (Fox 1996). According to Casper's Rental Referral Service, approximately 100 apartments are available as of August 1996 (Batey 1996).

3.11.5.2 Mobile Homes

During the energy boom of the 1970s and early 1980s, many of the newcomers to the area lived in mobile homes in mobile home parks. During the latter half of the 1980s, as energy-related development waned and population decreased, many mobile homes were relocated as their owners moved to other areas. During the late 1980s, a portion of those residents who remained in Natrona County moved into comparatively low priced single-family residences. Many of the mobile homes vacated by these families were also relocated or removed from service. Consequently, mobile homes currently comprise a substantially lower portion of the total Natrona County housing stock than during the early 1980s, and there are not a large number of vacant mobile homes for rent. Conversely, the nine mobile home parks in Casper currently have a large number of vacant mobile home pads (Batey 1996).

3.11.5.3 Temporary Accommodations

Casper also has a substantial number of motels, hotels and RV parks. The community has a total of 29 motels and hotels with a total of 1,821 rooms, 11 RV parks and 9 mobile home parks (WDECD 1993). The summer vacancy rate for motels and hotels is about 24 percent but the winter vacancy rate may be as high as 58 percent (WLRA 1996). Some portion of these housing resources would be available for new temporary residents of the area.

3.11.5.4 Available Housing in Communities Near the Project Area

Although housing is available in Casper, few housing units are available in Waltman, or any of the other unincorporated settlements along U.S. Highway 20/26. Natrona County has received inquiries regarding the construction of housing resources closer to the project area but no firm plans for development have been announced (Curran 1996).

3.11.6 Poverty and Social Services

The Natrona County unemployment rate has decreased substantially since 1986; however, the unemployment rate for Natrona County remains substantially above the State rate. High unemployment and the decline in the number of higher paying mining- and manufacturing-sector jobs and the increase in typically lower-paying retail and service jobs is believed to be a contributing factor to the high number of food stamp recipients in Natrona County. According to FY 1995 statistics from the Wyoming Department of Family Services, Natrona County had a 26.7 percent higher rate of food stamp recipients per capita than the State as a whole and a 24 percent higher rate than Laramie County (WDFS 1996). Economic factors such as unemployment and underemployment are two of the major problems for clientele of the Natrona County Human Services Commission (Royal 1996) and the Wyoming Department of Family Services (Heimer 1996).

3.11.7 Local Government and School District Facilities and Services

Many of the local government and school district facilities within the study were originally designed and constructed during the peak years of the energy boom. Consequently, these facilities can accommodate a substantially higher population than currently exists.

3.11.7.1 Natrona County

Law enforcement and criminal justice systems (along with county roads which are discussed in Section 3.3) are the primary county-operated facilities which could be affected by the proposed action and alternatives. Natrona County has recently completed construction of a new jail facility in Casper which has capacity to accommodate approximately 220 inmates. Current staffing levels are adequate for the County Sheriff's Department; however, there is no resident deputy living along the U.S. Highway 20/26 corridor. Residents of the area have requested that a deputy be stationed in the area due to its distance from the Sheriff's Department headquarters in Casper (Dovala 1996).

3.11.7.2 City of Casper

The public infrastructure of the City of Casper was designed to serve a larger population than currently resides in the City (Hough 1996). The water, wastewater treatment and solid waste systems are adequate to serve the existing population with substantial excess capacity (Stuckert 1996). The existing hospital, medical facilities, and personnel are sufficient to serve the current population (Shrader 1996). Police and fire service personnel and equipment in Casper are adequate for the existing population (DeWerk 1996).

3.11.7.3 Fire Protection Services

Fire protection services in the project area are provided by the Natrona County Fire Prevention District. This entity also provides emergency medical and hazardous material response services in the project area. Equipment and personnel have been adequate to serve the existing population and commercial activity in western Natrona County (Young 1996). The District has some emergency response equipment in Powder River and larger equipment in Casper.

3.11.7.4 Schools

Schools in the Natrona County School District are more than adequate for the existing population and generally could support reasonable population growth (Kammerer 1996). The District has experienced a gradual decline in enrollment over the past few years; consequently some of the smaller elementary schools in Casper have been difficult to support with existing neighborhood populations. This situation may improve in the upcoming school year with the elimination of neighborhood boundaries.

The proposed action and alternatives could affect the level of local ad valorem tax revenues available for the Natrona County School District as well as the amount of revenue generated for the Wyoming Foundation Program. In 1995, the District had the seventh lowest assessed valuation per ADM (Average Daily Membership) of the 49 school districts in Wyoming. A summary of major sources of revenue in school year 1995-96 for the District is presented below in Table 3-27.

Table 3-27. Revenue Summary Natrona County School District 1995-96.

Revenue Source	Dollars Received	Percentage of Revenues
County Ad Valorem Taxes	9,318,793	14.06%
Motor Vehicle Taxes	2,341,481	3.53%
Foundation Program	42,177,282	63.65%
State Land Income	9,042,679	13.65%
Interest Income	474,755	0.72%
Other Local Revenue	1,725,527	2.60%
Other State Revenue	1,184,574	1.79%
Federal Revenue	0	0.00%
Totals	66,265,091	100.00%

Source: Natrona County School District

3.11.8 State Fiscal Conditions and Mineral Tax Revenues

State revenues potentially affected by the proposed action and alternatives include severance tax, state mineral royalties, state sales and use tax and the state share of federal mineral royalties. Also, a portion of County ad valorem taxes are remitted to the State for public education. Below (Table 3-28) is a summary of recent mineral revenue trends.

The most important source of revenue for the Wyoming General Fund is the State sales and use tax. In FY1995, the sales tax provided 41% of General Fund revenues while the use tax provided 6.1% and the severance tax provided 12.7% (CREG 1996). Since FY1990, the State's share of sales and use tax revenue has increased more than 100%. This dramatic increase is at least partially explained by a July 1, 1993, increase in the state-imposed sales and use tax rate from 3% to 4% and a change in the distribution to allocate 72% to the State and 28% to the county of origin. This increase in the sales and use tax rate is scheduled to remain in effect until June 30, 1997.

Table 3-28 depicts the revenues received by the State of Wyoming from severance taxes for calendar years 1990 to 1995 from production of various minerals. Over the six-year period, total severance tax revenues declined by more than 25 percent. In calendar year 1995, total state severance tax revenues (including penalties and interest) were distributed to various funds: Wyoming General Fund (30.83%); Permanent Mineral Trust Fund (23.66%); Budget Reserve Account (14.43%); Water Development Accounts (10.33%); Highway Fund (8.62%); Cities and Towns (6.56%); Counties (2.19%); and the remainder to other accounts (3.38%). The percentages above reflect the amount distributed to each fund as a percentage of total revenue. To arrive at these percentages, different statutory distribution rates are applied to severance tax revenues and penalty and interest revenues.

Table 3-28. State of Wyoming Severance Tax Revenues by Mineral for Calendar Years 1990 to 1995 ($000s).

	1990	1991	1992	1993	1994	1995
Crude Oil	106,770	84,191	77,331	66,271	53,999	59,082
Natural Gas	52,753	45,182	59,122	70,277	54,591	43,255
Coal	93,419	103,815	100,349	75,192	72,922	83,060
Trona & Other	9,972	12,109	11,758	7,882	7,769	10,180
Penalty & Interest	2,559	3,003	7,351	6,976	7,561	1,142
Totals	265,473	248,300	255,911	226,598	196,842	196,719

Source: Wyoming Division of Economic Analysis (3)

Table 3-29 illustrates the revenues received by the State of Wyoming from Federal Mineral Royalties for calendar years 1990 to 1995 from production of various minerals. Over the six-year period, total severance tax revenues declined by more than 10 percent. In calendar year 1995, the State's share of Federal Mineral Royalty revenues (including rents, bonuses and other revenues) were distributed to various funds: Wyoming School Foundation Program (40%);

Highway Fund (23.4%); Capital Construction for Cities, Towns, Counties and Special Districts (9.8%); Cities and Towns (8.37%); University of Wyoming (6%); Legislative Royalty Impact Account (4.3%); Highway Fund for County Roads and State Aid to County Roads (4%); School Districts Capital Construction (2.4%); and the remainder to other accounts (1.73%). The percentages above reflect the amount distributed to each fund as a percentage of total revenue. To arrive at these percentages, different statutory distribution rates are applied to federal mineral royalty revenues and rents, bonuses and other revenues.

Table 3-29. State of Wyoming Federal Mineral Royalty Revenues by Mineral for Calendar Years 1990 to 1995 ($000s).

	1990	1991	1992	1993	1994	1995
Crude Oil	81,305	61,921	56,528	45,079	34,991	36,736
Natural Gas	34,906	32,706	29,223	48,521	45,897	34,048
Coal	55,596	73,579	71,860	75,254	79,604	88,674
All Other Minerals	8,614	10,471	9,309	7,266	8,249	9,753
Rents, Bonuses & Other	38,706	5,334	20,040	21,717	82,416	30,205
Totals	219,127	184,011	186,960	197,837	251,157	196,719

Source: Wyoming Division of Economic Analysis (3)

Ad valorem taxes are levied on real property and mineral production in each county in Wyoming. These revenues provide substantial funding for public schools and local governments in the State. In 1995, mineral production comprised 53.2% of the total assessed valuation in the State. Residential property made up 17.9%, commercial property 6%, industrial property 9.9%, agricultural property 3.8%, and other state assessed property (including utilities, railroads and pipelines) 9.1%. Ad valorem taxes levied in 1995 in all counties totalled about $430 million. Of this amount, about $305 million (71 percent) of this was collected for public schools. The remaining 29 percent funded county governments (19.7 percent) and special taxing districts (4.2 percent) (WTA 1995).

The Wyoming School Foundation Program provides a mechanism for equalization of funding for K-12 public education in Wyoming. The Foundation Program attempts to provide for a minimum level of educational services to each school district in the state by augmenting local revenues in school districts with insufficient local revenues. In 1996 it was declared unconstitutional by the Wyoming Supreme Court and the Legislature is currently working on development of a new funding mechanism. In 1995, about 24.5% of the ad valorem tax revenues collected for public schools were channeled directly to the State for the Foundation Program (WTA 1995). The remaining 75.5 percent were retained by the individual school districts (with some of this portion being sent to the Foundation Program in recapture districts).

The largest single source of revenue for the Foundation Program in 1995 was a special appropriation of $90,217,000 (33.9 percent). Ad valorem taxes on property and mineral production contributed 29.1% of the Foundation Program's revenues in 1995. Federal mineral royalties contributed the third largest share, 28.9 percent. The remaining 8 percent of Foundation Program Revenues were provided by recapture of local revenues from more wealthy districts, motor vehicle taxes, interest income and other sources (Education 1995).

3.11.9 County Fiscal Conditions and Mineral Tax Revenues

Natrona County revenues potentially affected by the proposed action and alternatives include ad valorem taxes and sales and use tax revenues. FY 1995 ad valorem taxes comprised about 27 percent and sales and use tax revenues contributed about 29 percent of the $12.4 million in total general fund revenues for Natrona County. Table 3-30 displays 1995 ad valorem tax revenues for the various taxing entities in the County. Total sales and use tax revenue distributed to Natrona County in FY1995 was $3,382,803 (Widdup 1997).

Table 3-30. 1995 Natrona County Ad Valorem Revenues by Taxing Entity.

Taxing Entity	1995 Mill Levy	1995 Revenue
Natrona County(1)	10.410	2,663,000
School Foundation Program	12.000	3,279,535
School District #1	39.500	10,795,135
County Library	1.110	303,357
County Fair	0.480	131,181
Community College	7.000	1,913,062
Weed & Pest Control	1.500	409,942
Total Natrona County	72.000	19,495,212

Source: PIC estimates; (1) Natrona County Treasurer; Wyoming Taxpayers Association (1995 mill levies)

Ad valorem taxes are assessed on the value of real property and mineral (including oil and gas) production. FY 1995 Natrona County assessed valuation totaled $273,294,561, which was a 5.5 percent decrease from the FY 1994 total. Of the FY 1995 total, mineral production comprised about 25 percent. Natrona County's mineral production valuation has declined significantly since 1991 as illustrated in Table 3-31 and Figure 3-20. Since 1991, oil production valuation has declined by more than 59 percent and overall mineral production valuation has declined by more than 56 percent. This substantial decline in assessed valuation has caused Natrona County to raise the general fund portion of the County's mill levy four times in the last five years. In FY 1995, Natrona County had the third-lowest per capita assessed valuation in Wyoming.

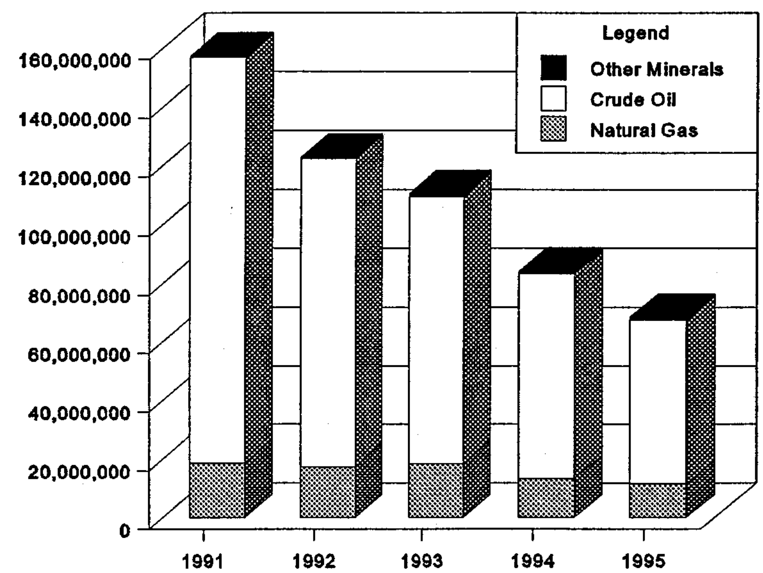
A summary of estimated mineral production valuation, total assessed valuation and County general fund mill levies are provided in Table 3-31. The assessed valuation figures are from the 1991 through 1995 editions of *Wyoming Property Taxation* (WTA 1991-1995). Rising commercial and residential assessed valuation have made up for some of the decline in mineral assessed valuation over the period. However, Natrona County's total assessed valuation has declined by more than 22 percent from 1991 to 1995 (WTA 1991-1995).

Table 3-31. Mineral Production Valuations. Natrona County, Wyoming FY 1991 to FY 1995.

MINERAL COMMODITY	1991	1992	1993	1994	1995
Natural Gas	$ 18,690,340	$ 17,342,026	$ 18,423,572	$ 13,315,526	$ 11,535,253
Crude Oil	$137,903,139	$ 104,860,060	$ 91,023,172	$ 69,758,225	$ 56,011,463
Other Minerals	$ 598,716	$ 673,289	$ 1,024,435	$ 1,082,199	$ 1,014,924
Total Mineral Valuation	$157,192,195	$ 122,875,375	$110,471,179	$ 84,155,950	$ 68,561,640
Total Assessed Valuation	$352,060,091	$ 331,823,597	$308,588,548	$289,163,717	$ 273,294,561
General Fund Mill Levy(1)	7.670%	8.940%	8.940%	9.150%	10.410%

Source: Wyoming Taxpayers Association (1), PIC Calculations

Figure 3-20. Natrona County Mineral Production Valuation, 1991-1995.



Source: Wyoming Taxpayers Association

As a result of this decline in mineral production revenues, the County has been compelled to use more of its resources for general government expenses. Examples of measures taken by the County to compensate for falling mineral revenues include the following (Widdup 1996):

- The County Records Management Department was eliminated.
- County funding for Public Health and Recreation has decreased substantially since Fiscal Year (FY) 1993.

- In FY 1994 all departments were required to reduce staff levels a minimum of one full-time equivalent (FTE).
- The County Fire Department was required to become a separate district with its own mill levy.
- The Natrona County Airport was required to become self-supporting in FY 1995.

In addition to the decline in mineral tax revenues, Natrona County faces reductions in another important revenue source. Because approximately 43 percent of the land in Natrona County is owned by the Federal Government, Payment In Lieu of Taxes (PILT) payments are an important source of revenues. Due to a change in the allocation formula used to calculate PILT payments and a shortage of appropriated funds, in FY 1995, Natrona County's PILT payments were reduced by about $153,000 (or 15.4 percent).

3.12 TRANSPORTATION

The regional transportation system serving Natrona County and the project area includes an established system of interstate, state and county roads. The Burlington/Sante Fe Railroad maintains a rail line serving the County. Commercial and general aviation services are available at the Natrona County International Airport.

3.12.1 Access

Primary access to the project area is provided by:

- U.S. Highway 20/26, a paved, two-lane, primary highway which connects Casper with Thermopolis (via U.S. 20) and Riverton (via U.S. 26),
- Natrona County Road 104 (Arminto Road), a 2-lane rural road. The first 10 mile section of Arminto Road is hard-surfaced; the remainder of the road is gravel-surfaced.

Access to the Project area from Casper, Riverton, Shoshoni and other towns and municipalities is provided by U.S. Highway 20/26 and Arminto Road.

3.12.2 Level of Service, Traffic Volumes and Accident Statistics

The level of service on U.S. Highway 20/26 between the town of Mills and Waltman is substantially within Wyoming Department of Transportation (WYDOT) standards. This segment of the highway has sufficient unused capacity to accommodate substantial increases in traffic volumes before tolerable standards would be exceeded (Rounds 1996). Table 3-32 provides information concerning 1994 and 1995 traffic volumes and 1995 accident rates for the highways identified above.

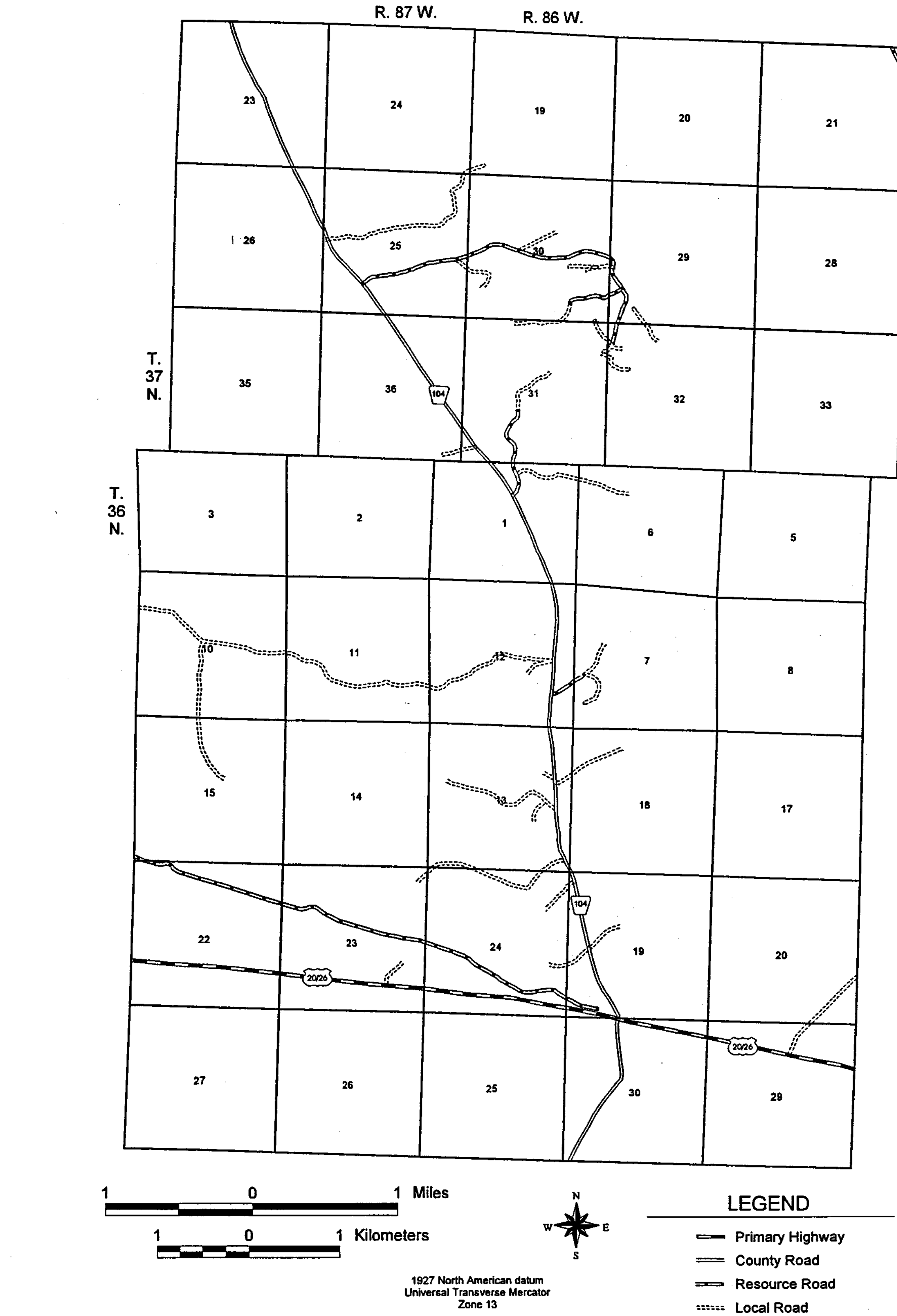


Figure 3-21. Transportation Routes within the Cave Gulch-Bullfrog-Waltman Project Area.

Primary uses of Arminto Road include access to oil and gas activities within the project area, access to recreation areas within the southern Big Horn mountains, and local resident traffic. No traffic counts were available for the road, however, recent development within the project area has increased traffic levels (Sullivan 1996). Arminto Road is part of a route which has been designated by the U.S. BLM as a Back Country Byway. A Back Country Byway interpretive site is located within the project area.

Table 3-32. Current Traffic and Accident Information.

Highway Segment (mileposts)	1994 ADT All Vehicles Wtd. Avg.	1995 ADT All Vehicles Wtd. Avg.	1995 Accidents per Million VMT*	1995 Average Accident Rate by hwy. class.
US Highway 20/26 Mills to Waltman (mp 4.64 - 50.69)	3,241	3,314	0.92	1.09
Natrona County 104 (Arminto Road)	n/a	n/a	n/a	n/a

Source: Wyoming Department of Transportation (1) (2) and (3), PIC Calculations.
(*Vehicle Miles Traveled)

3.12.3 Existing Transportation System and Conditions within the Project Area

A transportation network has been developed incrementally within the project area to serve the oil and gas development which has occurred over the past 35 years. Consequently, a system of collector, local and resource roads currently exists. The road system in the project area (Figure 3-21) includes approximately 174 miles of public and private, improved and unimproved roads. Roads within the project area are maintained by the operators.

U.S. Highway 20/26 is maintained by the Wyoming Department of Transportation. Arminto Road is currently maintained by the Natrona County Road, Bridge and Parks Department. The only sustained maintenance problems associated with current or past oil and gas activities in the project area involve damage to Arminto Road resulting form hauling gravel to the project area from the north (Sullivan 1996). Natrona County intends to negotiate with the field operators to cover the cost of repairing damage that has already been experienced on Arminto Road.

3.13 HEALTH AND SAFETY

Several health and safety concerns within the project area are discussed elsewhere in this document, including: traffic accidents (see Transportation section), vehicle-animal collisions (see Wildlife section), flood (see Water Resources section), landslides and earthquakes (see Geology/Paleontology section). The Proposed Action and project alternatives, as discussed in Chapter 2 incorporate measures intended to reduce potential health and safety impacts. Health and Safety and related concerns are discussed in this section.

3.13.1 Sanitation

No central sewage, potable water or solid waste disposal facilities are found near project locations.

3.13.2 Firearms Accidents

Workers and visitors to the analysis are exposed to this risk during hunting seasons, by casual firearm use associated with plinking or target shooting, and by the transport of firearms in vehicles.

3.13.3 Criminal Activities

Property crimes, such as vandalism and pilfering of tools or construction supplies, often occur at well field drilling and construction sites. However, the Natrona County Sheriff's Office has not observed any change in the frequency or seriousness of criminal activity in the analysis during the recent development activities (Kinghorn, 1996).

3.13.4 Fire

The presence of fuels, condensate storage tanks and gas processing equipment increases the chance of fire in the project area compared to lands where no oil and gas development has occurred. Lightning strikes to field equipment have caused well field fires in Wyoming. Welding equipment, an accidental rupture of a gas line, the operation of construction equipment, or failure of a piece of drilling or production equipment are all existing sources of fire hazard in the project area. Because recreation visitation in the project area is so low, campfires, another common source of wildfire, are uncommon. Workers in the project area currently serve as informal fire watches and have made themselves available to Natrona County personnel in emergency situations.

3.13.5 Occupational Hazards

Compared to workers in the service sector, the risk of a work-related injury is much greater for individuals working on drilling or completion rigs, operating heavy equipment or working at construction sites. However, once drilling and construction activities have been completed, the potential risk of a work-related accident declines during field operations and maintenance.

3.13.6 Well Blowout

Such an event is uncommon. In an analysis completed by the Montana Board of Oil and Gas Conservation, one blowout was found in a sample of 4,242 wells (Montana Board of Oil and Gas Conservation, 1989, *Programmatic Environmental Impact Statement on Oil and Gas Drilling and Production in Montana*, p. 107-111). No hydrogen sulfide was involved in any of the sample wells. Other work referenced in that study (p. 108) found that in a sample of 12,000 wells completed in the State of Wyoming, two blowouts had occurred during drilling. Potential causes include insufficient mud weight during pipe trips, penetration of high pressure gas zones or lost circulation. As noted in the technical appendix to the Montana study (p. 105), blowouts on active wells are also uncommon--approximately 1 per 4,938 active wells in a sample of wells taken in Alberta, Canada. Typical causes of blowouts on active wells included collision of a vehicle with a wellhead or lack of proper maintenance.

Under its Onshore Oil and Gas Order No. 2, BLM has established minimum levels of performance for well control that include standards for blowout prevention equipment, casing, cementing, mud programs and drill stem testing. BLM specifies four parameters of primary importance in the selection of blowout preventers: known or anticipated pressures, geologic conditions, accepted engineering practice and the characteristics of the surface environment. The pressure rating of the blowout preventers used on BLM lands in the project area must exceed the anticipated surface pressure of the well. BLM standards also address the choke manifold system, pump capacity and power availability for closing blowout preventers. The American Petroleum Institute has developed various standard equipment configurations which will meet BLM standards. These requirements must be addressed in the drilling plan which BLM requires (under Onshore Oil and Gas Order No. 1) to be submitted as part of the APD.

3.13.7 Hydrogen Sulfide

Hydrogen sulfide (H_2S) is a poisonous gas that presents a significant risk to workers and the public where it is associated with oil or gas reservoirs. Threshold limitations for worker exposure to hydrogen sulfide and sulfur dioxide have been established by the federal Occupational Health and Safety Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH). With its Onshore Oil and Gas Order No. 6, BLM adopted national requirements and standards of performance expected from operators when conducting operations involving oil or gas reservoirs that could reasonably be expected to contain hydrogen sulfide. No hydrogen sulfide gas is associated with current production operations and the gas has not been associated with the target producing formations in the project area.

3.13.8 Pipeline Failure

Under 49 CFR 191 operators of natural gas transmission and gathering systems are required to notify the U.S. Department of Transportation (DOT) when a reportable incident occurs. Under current regulations (49 CFR 191) a reportable incident means an event that involves a release of gas from a pipeline and a death, or personal injury necessitating in-patient hospitalization or an estimated property damage of $50,000 or more. The operator is required to submit an incident report (Form RSPA F 7100.2) no more than 30 days after detection of the incident. However, under 49 CFR 191.1 DOT reporting requirements do not apply to onshore gathering of gas outside the limits of an incorporated or unincorporated city, town, or village or outside of a designated residential or commercial area such as a subdivision, business or shopping center, or community development. This lack of data for more remote gathering systems makes it difficult to provide an up-to-date estimate of the rate of recent pipeline failures in such situations.

Up until 1984, reporting regulations covered a broader range of incidents including one that required taking a segment of transmission line out of service; resulted in gas ignition; caused estimated damage of $5,000; required immediate repair on a transmission line or occurred while testing with gas or other medium. This change in reporting requirements has complicated a comparative evaluation of pipeline failures and accident rates. In addition, pipeline failures tend to be more common on older and on smaller diameter lines. For example, older pipelines lacked the more durable coatings and cathodic protection systems now common on new pipeline systems. Similarly, past reports show that large diameter transmission pipelines tended to have lower failure rates than small gathering lines. These factors further complicate attempts to provide exact, up-to-date estimates of potential failure rates for remote gathering systems.

However, several sources of gas pipeline incident rates were reported in a study published by the State of Montana (Montana Board of Oil and Gas Conservation, 1989, *Programmatic Environmental Impact Statement on Oil and Gas Drilling and Production in Montana, Technical Appendix, p. 109).* Sources included the DOT date (up to 1984), Texas Railroad Commission, and the Energy Board of Canada. Reported incident rates for sweet gas ranged from 1.1 to 4.1 per thousand miles of natural gas pipeline. DOT statistics show about 1 to 2 incidents per 1,000 miles of reporting transmission and gathering system in the US depending upon the year examined. Common causes of accidents include: damage by bulldozers and backhoes, earth movement due to washouts or landslides, willful damage and human error.

3.13.9 Hazardous Materials

BLM policy (*Instruction Memorandum 93-344, 9/9/1993*) on hazardous materials requires identification of the following:

> *(A) any chemical or chemicals from the Environmental Protection Agency's Consolidated List of Chemicals Subject to Reporting under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986, 10,000 pounds of which will be used, produced, stored, transported, or disposed of annually in association with the Proposed Action (regardless of exemption status) and (B) are extremely hazardous substances, as defined in 40 CFR 355, which will be used, produced, stored, transported, or disposed of in association with the Proposed Action (regardless of exemption status).*

The Operators have prepared a Hazardous Substances Management Plan (Appendix D) that identifies potentially hazardous materials, regardless of quantity, which could be used in well drilling, completion or production activities within the project area. The plan identifies potentially hazardous materials--mainly fuels, lubricants and hydraulic fluid--which could be used in related construction activities such as road building. The plan also provides a Management Policy and Procedure section that describes how the Operators would comply with emergency reporting requirements.

3.14 NOISE

Under the programmatic environmental assessment for oil and gas leasing in the Platte River Resource Area (p. 29), oil and gas leases can be issued with stipulations which under specified conditions would require an operator to equip the engines powering a drilling rig with mufflers that would prevent noise levels from exceeding 86 decibels (dBA) at 50 feet. Similarly, under specified conditions BLM can require that exhaust pipes of engines used in oil and gas development be directed away from noise sensitive areas. Situations in which the stipulations described in the EA would be applied include drilling and/or production equipment in the vicinity of a dwelling, subdivisions or recreation areas. None of these conditions occur in the vicinity of proposed development. Federal oil and gas leases proposed for development do not incorporate these stipulations.

Federal, state and local jurisdictions have adopted noise standards for various situations. In general, these standards can be categorized as equipment standards or environmental standards.

Equipment standards are typically set at the federal level. State and local jurisdictions are constitutionally limited in their authority to impose equipment standards. An equipment standard, for example, would be a requirement that all passenger cars have a muffler which effectively reduces noise at the tailpipe to a specified dBA. Environmental noise standards are applicable to a geographic setting. Examples of environmental noise standards include a county noise ordinance or a noise standard for a work environment such as an underground coal mine. No state or local environmental noise standard has been set for the project area. Federal noise standards applicable to project activities are limited to occupational noise exposure standards (e.g., 29 CFR 1910.95) and noise standards for construction equipment, medium and heavy weight vehicles (e.g., see 40 CFR 204). Under federal regulation (29 CFR 1910.95), the following workplace noise standards intended to protect workers' hearing have been adopted (Table 3-33). Where the following noise levels and duration would be exceeded employers must provide hearing protection to ensure such levels are not exceeded.

Table 3-33. Permissible Occupational Noise Exposure Standards as Adapted under Federal Regulation (29 CFR 1910.95).

Duration Per Day, In hours	dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Pumpjacks driven by internal combustion engines are the most common type of long-term noise associated with oil and gas development. Where pumpjacks are driven by electric motors they are virtually inaudible from 100 feet away if wellhead equipment has been properly maintained and lubricated. However, no pumpjacks have been proposed under the Proposed Action or project alternatives and this source of noise is not examined further in this document. Currently, the most common, long-term source of noise in the project area is vehicle traffic and field compressors. Drilling, construction and completion activities are a short-term, temporary source of noise. Otherwise, infrequent, unpredictable sources of noise include venting of pipelines or well blow downs. Blasting is not a typical part of drilling or construction activities in the project area; therefore, potential noise impacts from this source are not examined further in this document.

The BLM has estimated that the average noise level in the Platte River Resource Area is between 30 and 40 dBA (BLM, PRA Programmatic EA, p. 56). This is about the range suggested in other environmental impact statements and has been confirmed by actual field measurements taken elsewhere in Wyoming (Kruger 1981). However, this background condition will be affected by atmospheric conditions, wind levels, topography, vegetation, time of day, bird and human activity. At times, background noise in the project area is likely to exceed 40 dBA (Kruger 1981).

Table 3-34. Noise Level Comparison Chart[1].

dBA[5]	How it Feels	Equivalent Sound	Loudness Compared to 75 dBA	Actual Noise Measurement Data[2]
135	Damage to ears	Jackhammer	64x	
125	Pain to ears		32x	
115	Uncomfortable	Unmuffled motorbike at 2-3 feet	16x	
105	Discomfort threshold	Unmuffled motorcycle at 25 feet	8x	Maximum (Lmax[6]) at borrow ditch during passage of heavy truck traffic on gravel road
95	Very loud conversation stops	Older power lawnmower	4x	Maximum (Lmax[6]) level recorded for a diesel electric drill rig at 100 feet[3]
85	Intolerable for phone use	Steady flow of freeway traffic	2x	Maximum (Lmax[6]) recorded at 25 feet from borrow ditch during passage of heavy truck traffic on gravel road
75	Extra auditory physiological effects	Passenger car at 65 mph at 25 feet	0 (75 dBA)	Average (Leq[4]), diesel-electric drill rig at 100 feet[3]
55	Sleep interference	Normal conversation Natural gas driven pumpjack at 200 feet	1/4x	Average (Leq[4]) noise level recorded in an active, intensely developed oil field (LaBarge, Wyoming) during the afternoon (2:00 PM)
30 to 35	Typical background noise level in rural area	Ambient noise level measured in residential area, Jackson, Wyoming[2]	About 1/6x	Maximum (Lmax[6]) recorded for a diesel-electric drill rig at 2,000 feet[3] Lmax recorded at 50 feet from borrow ditch during passage of oil field heavy truck traffic on gravel road

1. Approximate dBA levels. Source: BLM Great Falls Resource Area, 1990, *Blackleaf EIS*, as based on Federal Energy Regulatory Commission, *Final EIS on Trailblazer Pipeline System*, FERC/EIS-0018.
2. Actual noise level field data reported in Paul W. Kruger, *Report on Climate, Air Quality, and Noise for the Cache Creek-Bear Thrust Environmental Impact Statement*, U.S. Geological Survey Open File Report 81-859, June, 1981.
3. Diesel-electric drill rigs had 3 CAT or 3 GM-EMD engines; measurements were taken on clear, calm days in October at rigs near Evanston, Woodruff Narrows and Whitney Canyon, Wyoming.
4. Leq = Equivalent continuous sound level. The average sound level over a 24 hour period. There can be times when the noise is higher of lower than this dBA level.
5. dBA = average sound level in decibels.
6. Lmax = the greatest sound level during a measurement interval or event.

Table 3-35. Actual Reported Measurements Noise Generated by Diesel Engines Used on Drilling Rigs[1]

Distance from Source	Diesel-Electric Rig (dBA)[2]					Compound Rig (dBA)[3]		
	Noble #132[2]	Apollo 4	Amoco GF102	MGF #101[3]	Chevron #1-30F, Loffland Rig #30	Carter Creek #1-18F	Amoco 457, BOMAC #44	Apache #3-23, Rodan Rig #6
At engines	105	97	110	96	103	99-107	103-106	85-100
100 feet[3]	73-78	63-75	72-74	72-78	72-79	72-80	69-80	70-83
400	60-69	55	55-60	65-70	59-64	61-70	60-75	58-73
Terrain	mountains	rolling hills, bluffs	rolling hills, open	ridge top	valley	in canyon area	ridge top	rolling sage hills
Engines	3 GM-EMD	Not reported	Not reported	3 CAT D399	3 CAT D398	Wakasha	3 CAT D379	GM

1. Actual noise level field data collected for Paul W. Kruger, *Report on Climate, Air Quality, and Noise for the Cache Creek-Bear Thrust Environmental Impact Statement*, U.S. Geological Survey Open File Report 81-859, June, 1981.
2. Measurements for diesel-electric rigs were for all drilling operations. Sound levels varied with direction from the rig; therefore, a range of measurements is shown.
3. Sound levels for compound rigs were measured for engines idling and under load. Sound levels also varied with direction from the rig. Minimum and maximums reported are shown here. At any specific point, field notes indicate about a 7-10 dBA difference between engines idling and under load on a compound rig.

It is difficult to accurately predict decibel levels for diesel engines, compressors and heavy equipment used in well field development. Actual noise levels for any given engine type will vary, depending upon operating conditions, type of muffler and exhaust system used, load on the engine, quality of fuel, and other conditions. And, according to a noise control specialist with experience in mitigating noise from drill rigs in urban areas, manufacturers' noise ratings are not particularly reliable or good predictors of actual field conditions (Van Houten 1997). Actual field measurements taken over the course of days exhibiting different wind, weather and levels of human activity are needed. For comparative purposes, estimates of common sources of noise are compared to actual noise measurements taken during oil and gas drilling operations in Wyoming (Table 3-34, Table 3-35).

In general, Kruger (1981) found that average noise levels around a drilling rig were 74 dBA at 200 feet, 64 dBA at 400 feet and at "whisper level" (25 dBA) at about 3/8 mile. He noted that mufflers installed on drill rig engines could be capable of up to a 30 dBA reduction in noise levels at certain frequencies.

Large compressor stations typically use a series gas-fired engines each capable of generating 750 to 3,300 horsepower or more. On interstate pipeline systems, new stations can be found less than 0.5 miles from a residence. In these situations, noise mitigation measures include housing compressors in a building, insulating the building and installing improved mufflers and exhaust systems. Much can be done to retrofit engine locations to effectively dampen noise (Van Houten 1997). Where noise is an issue, field measurements can help determine the most effective mitigation methods. No compressor stations or engines of this size described below (Table 3-36) are found in the project area or are proposed. Field compressors typically are in the range of 250 horsepower. Noise from such compressors recedes to background much more quickly that the stations noted here. However, data is available for larger compressor stations and is offered here as an example of how noise impacts diminish with distance. Noise levels from a liquids recovery plant would likely be less than that generated by one of the interstate pipeline compressor stations described below.

Table 3-36. Estimated Noise Levels Associated with Major Compressor Station Facilities[1].

Fuel	Combined Engine Sizes (horsepower)	Distance to Noise Sensitive Area (feet)	Total dBA at Noise Sensitive Area (dBA)
natural gas	6,670	2,900	45.2
natural gas	10,005	2,335	49.3

1. Stations of this size are not found in the project area, nor have any been proposed.
2. Source: Federal Energy Regulatory Commission, 1996, Draft Pony Express Pipeline Environmental Assessment. Estimates were for equipment under full load.